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Cost Estimating Handbook for Transfer, Shredding and Sanitary Landfilling of Solid Waste

Booz-Allen & Hamilton, Inc.

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Cost findings for 12 solid waste transfer stations averaged $4.45 per ton for operating costs and $.94 per ton for capital costs in 1975. Average capital investment was $780,000 per community. Average costs for 10 shredder facilities in 1975 were $5.61 for operating costs and $1.69 per ton for capital. Average capital investment was nearly 2 million dollars per facility. Data from 17 landfills indicated operating costs averaged $2.38 and capital costs 68 cents per ton in 1975. Labor was the largest operating cost item at all facilities accounting for 55 percent at transfer facilities, 39 percent at shredding facilities and 50 percent at landfills.

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The following definitions or footnotes were omitted and should be added.

Table 11, Page 22

1. Capacity in tons per hour is the manufacturer's rated capacity
2. Storage capacity (tons) is pit storage only
3. Resultant particle size refers to nominal size

Table 13, Page 25

1. Electricity and other costs based on prevailing rates in the locality.

Table 20, Page 40

1. Average tons per day processed. This does not denote continuous operation nor can it be correlated with shredder manufacturer's rated capacity. It is generally dependent on material available at the facility.
2. Site 1 includes building
3. Site 2 shreds bulky items at an energy recovery plant as material is available.
4. Site 3 is an outdoor installation at a landfill site with no building.

COST ESTIMATING HANDBOOK FOR TRANSFER, SHREDDING AND SANITARY LANDFILLING OF SOLID WASTE

This final report (SW-124c) describes work performed for the Federal solid waste management programs under contract No. 68-01-3121 and is reproduced as received from the contractor with some deletions and minor editorial corrections.

U.S. ENVIRONMENTAL PROTECTION AGENCY

1976

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An environmental protection publication (SW-124c) in the solid waste management series.

FOREWARD

In response to numerous requests for cost information on selected solid waste functions, the Environmental Protection Agency initiated a study with Booz, Allen & Hamilton Inc. to develop cost estimating procedures for use by local solid waste managers in projecting the capital and operating costs of solid waste transfer, shredding and landfilling systems in their communities. EPA Contract Number 68-01-3121.

This project is part of a broad technical assistance program being carried out by the Office of Solid Waste Management Programs in EPA to help communities improve their solid waste management. It was conducted under John W. Thompson, Project Manager.

Special appreciation is expressed to the following jurisdictions for their cooperation in supplying the data used in the preparation of the handbook:

Transfer Systems

- Arlington County, Virginia
- Brookline, Massachusetts
- Dearborn Heights, Michigan (Central Wayne County Sanitation Authority)
- Detroit, Michigan
- Hamilton, Ohio
- Hanover, Massachusetts
- Hollywood, Florida
- Lancaster, Pennsylvania (Lancaster Area Refuse Authority)
- Orange County, Florida
- Pensacola, Florida
- Richardson, Texas
- Santa Monica, California
- Washington, D. C.

Shredders

- Charleston, South Carolina
- Chemung County, New York
- Chicago, Illinois
- Columbus, Ohio
- De Kalb County, Georgia
- Great Falls, Montana
- Harrisburg, Pennsylvania
- High Point, North Carolina
- Madison, Wisconsin
- Odessa, Texas
- Onondaga County, New York
- Tacoma, Washington
- Willoughby, Ohio

Sanitary Landfills

- Cape Girardeau, Missouri
- Fairfax County, Virginia
- Fresno, California
- High Point, North Carolina
- Independence, Missouri
- Joplin, Missouri
- Kenosha, Wisconsin
- Lancaster, Pennsylvania (Lancaster Area Refuse Authority)
- Madison, Wisconsin
- Nashua, New Hampshire
- Norfolk, Virginia
- Odessa, Texas
- Raleigh, North Carolina
- Richardson, Texas
- Toledo, Ohio
- Topeka, Kansas

- SHELDON MEYERS
Deputy Assistant Administrator
for Solid Waste Management

Table of Contents

Page	
1	Transfer Systems
14	Cost Estimating
21	Shredding
33	Cost Estimating
39	Bulky Item Shredding
48	Cost Estimating
53	Sanitary Landfilling
70	Cost Estimating

LIST OF TABLES

Table 1 Characteristics and Costs of 12 Transfer Systems in 1975
Table 2 Capital Costs for 12 Transfer Systems in 1975
Table 3 Annual Operating Costs for 12 Transfer Systems in 1975
Table 4 Operating Costs Per Ton for 12 Transfer Systems in 1975
Table 5 Depreciation Periods for 12 Transfer Systems in 1975
Table 6 Wage and Fringe Benefits Rates for 12 Transfer Systems in 1975
Table 7 Direct Hauling Costs for 12 Transfer Systems in 1975
Table 8 Average Daily Tons for Transfer System Personnel
Table 9 Transfer System Capital Cost Worksheet
Table 10 Transfer System Operating Cost Worksheet
Table 11 Characteristics and Costs of 10 Shredder Sites in 1975
Table 12 Capital Costs of 10 Shredder Sites in 1975
Table 13 Operating Costs of 10 Shredder Sites in 1975
Table 14 Operating Costs Per Ton of 10 Shredder Sites in 1975
Table 15 Depreciation Periods for 10 Shredder Sites
Table 16 Wage Rates and Fringe Benefits Rates for 10 Shredder Sites in 1975
Table 17 Direct Hauling Costs for 10 Shredder Sites in 1975
Table 18 Shredder Capital Cost Worksheet
Table 19 Shredder Operating Cost Worksheet
Table 20 Characteristics of 3 Bulky Item Shredders in 1975
Table 21 Capital Cost of 3 Bulky Item Shredder Sites in 1975
Table 22 Operating Costs of 3 Bulky Shredder Sites in 1975
Table 23 Operating Costs Per Ton of 3 Bulky Item Shredder Sites in 1975
Table 24 Depreciation Periods for 3 Bulky Item Shredder Sites
Table 25 Wage Rates and Fringe Benefits for 3 Bulky Item Shredders
Table 26 Direct Hauling Costs for 3 Bulky Item Shredders in 1975
Table 27 Bulky Item Shredder Capital Cost Worksheet
Table 28 Bulky Item Shredder Operating Cost Worksheet
Table 29 Characteristics and Costs of 17 Landfill Sites in 1975
Table 30 Capital Costs for 17 Landfills in 1975
Table 31 Operating Costs for 17 Landfills in 1975
Table 32 Operating Costs Per Ton for 17 Landfills in 1975
Table 33 Depreciation Periods for 17 Landfill Sites
Table 34 Wage Rates and Fringe Benefits for 17 Landfills in 1975
Table 35 Average Daily Tons for Landfill Personnel
Table 36 Equipment for 17 Landfills in 1975
Table 37 Operating and Capital Costs Per Ton for 3 Landfill Sites Receiving Shredded Wastes in 1975
Table 38 Land Costs for 17 Landfill Sites in 1975
Table 39 Landfill Capital Cost Worksheet
Table 40 Landfill Operating Cost Worksheet

FIGURE

Figure 1 Total Cost Per Ton U.S. Utilization for 10 Shredder Sites in 1975

SUMMARY

Solid Waste processing and disposal have become a major problem for many local governments in recent years. Primary factors contributing to the problem have been an increasing amount of solid waste, the need for new disposal sites, rising labor and equipment costs, and increased public awareness.

In response to these problems, many local officials are developing and evaluating alternative courses of action. Options under consideration include the installation of transfer systems, construction of shredder facilities, and the development of new sanitary landfills.

The purpose of this report is to provide capital and operating cost data for solid waste systems so that decision makers can evaluate and assess the estimated costs of alternative options.

Cost findings based on data collected in 1975 are summarized as follows:

Transfer systems. Operating costs for 12 communities averaged $4.55 per ton in 1975 and ranged from $1.84 to $10.72 per ton. Labor costs, including fringe benefits, averaged 55 percent; vehicular equipment, 34 percent; stationary equipment, 9 percent; and other, 2 percent. Capital costs averaged $780,000 per system, and accounted for an average additional $.94 per ton.

Shredding. Operating costs per ton for 10 communities in 1975 averaged $5.61, ranging from $2.85 to $9.50. Labor costs averaged 39 percent; stationary equipment, 27 percent; vehicular equipment, 15 percent; and other, 19 percent. The average capital cost was $1,940,000, amounting to an average additional $1.69 per ton.

Sanitary landfilling. Operating costs for 17 communities in 1975 averaged $2.38 per ton, ranging from $.98 to $5.41 per ton. Labor costs averaged 50 percent; vehicular equipment, 36 percent; and other, 14 percent. Capital costs averaged additional $.68 per ton.

INTRODUCTION

This handbook was developed to help local solid waste officials in (1) developing cost estimates for planning purposes; (2) developing budget estimates; (3) evaluating costs of alternative systems; and (4) evaluating cost proposals for solid waste systems submitted by vendors.

The cost estimates which may be prepared from this handbook should be considered preliminary or planning estimates. They cannot replace the estimates that are developed as part of a detailed engineering study for a particular system at a particular site. Every solid waste system is unique, in that no two systems will have identical capital and operating costs due to differences in land costs, labor rates, site characteristics, equipment selection, and many other factors.

Two basic assumptions have been made in the report. First, interest expense, or the cost of capital, has been excluded from the analysis since this expense was found to be treated inconsistently in the surveyed sites. Second, except for the section on Sanitary Landfilling, land was considered to be a nondepreciable asset. The Sanitary Landfilling chapter provides for situations where land is treated as a depreciable asset over the expected life of the landfill.

TRANSFER SYSTEMS

Transfer systems employ the concept of transferring solid waste from collection vehicles to larger capacity transfer vehicles for hauling to a disposal site. Generally, transfer trucks are tandum axle tractor/trailer vehicles, hauling 15 to 20 tons. Truck transfer systems are in operation in many areas of the nation where disposal sites are distant from urban areas and significant time would be spent by collection crews transporting the solid waste.

Truck transfer systems commonly utilize one of two methods in transferring wastes. In one, noncompacted solid waste is transferred directly into a larger transfer truck until capacity is reached. Another method involves a highpressure packing ram as part of a transfer truck or a stationary compactor which compresses the material to a fraction of its original volume. Both methods reduce the number of trips required to the disposal site.

The overall advantages of a transfer system are: (1) total solid waste management costs can be potentially reduced since nonproductive collection time can be cut; (2) communities can change landfill locations without changing the collection routes. A disadvantage of transfer systems is that large capital expenditures must be made for land, facilities, stationary, and vehicular equipment.

The characteristics of the 12 transfer systems are shown in Table 1. The sites are similar in that all the transfer stations are publicly owned and operated, and all but one of the systems employ stationary compactors. The average daily tonnage ranged from 112 tons to a combined tonnage of 880 tons for the two separate transfer stations operated by one jurisdiction. Operating days per year varied from 130 to 364, and number of station employees ranged from 1 to 24. The round-trip distance from the transfer station to the landfill ranged from 20 to 63 miles and averaged 31 miles.

The annual operating and annualized capital costs of the 12 transfer systems averaged $5.49 a ton. (Table 1) Operating costs were 82 percent of total annual costs, or an average of $4.55 per ton. Capital costs averaged 18 percent of total annual costs, or $.94 per ton. The costs include the operation of the transfer station and the round-trip truck haul to the disposal site but not the collection or the disposal costs.

Capital Costs

The average total capital cost per ton for the 12 sites was $.94, with a range of $.15 to $2.70 per ton. Annualized capital costs 18 percent of total annual costs and ranged from 2 to 42 percent.

The capital costs associated with a truck transfer system include those incurred in constructing the station and in purchasing the vehicular equipment in Table 2. Annualized capital costs were calculated for each cost category (except for land, which was considered to be a non-depreciable asset) by straight-line depreciation over the depreciation period (expected useful life) of each capital cost item, assuming zero salvage value, as follows:

$$\text{Annualized Capital Cost} = \frac{\text{Purchase Cost}}{\text{Depreciation Period (years)}}$$

Land. Only 3 of the 12 sites had purchased land on which to locate the transfer station. The land costs reported by the 3 sites were $13,000, $4,000, and $9,000. The remaining sites utilized land already owned by the jurisdiction.

Site Construction. The site construction costs ranged from $.01 to $.90 per ton, with an average of $.27, for the 11 sites that did not utilize an existing structure for the transfer station facility. The site construction category included costs for: engineering design; architectural services; site preparation, including demolition and grading; and construction of the transfer station facility.

Stationary Equipment. An average of $.11 per ton was spent for stationary equipment. Costs ranged from $.004 to $.33 per ton. Stationary

Table 1. CHARACTERISTICS AND COSTS OF 12 TRANSFER SYSTEMS IN 1975

Characteristic	Site No. 1	2	3	4	5	6	7	8	9	10	11	12 [1]	Average
Average Tons/Day	387	120	289	670	112	190	600	228	155	220	200	880	
Tons/Year (1,000)	110	30	33	174	35	49	180	82	49	57	60	229	
Days/Year of Operation	284	250	130	260	312	260	300	364	318	260	302	260	
Site Acreage	.5		3	2	1.75	2	2	1,500	1	5	1	4.5	
Round Trip Distance/Miles	40	63	22	(2)	20	23	35	45	27	25	20	53	
Round Trip Time/Hours	1.5	2.5	1	(2)	1	1	1.3	1.5	1.5	1.5	1.16	1.8	
Number of Shifts	2	1	1	1	1	1	1	1	1	1	1	1.5	
Number of Supervisors	1	1	1	1	.5	1	1	2	.5	1	4	4.5	
Number of Station Employees	11	3	4	7	1	2	5	7	3	4	10	44	
Number of Drivers	15	4	3	0	4	4	7	8	3	4	5	45	
Total Operating Costs:													
Total/Year (1,000 dollars)	723	236	94	1,293	98	163	330	321	127	129	176	2,337	--
Cost/Ton (dollars)	6.58	7.82	2.49	7.43	2.78	3.29	1.84	3.87	2.57	2.26	2.92	10.72	4.55
% of Total Cost	98	74	58	87	80	83	80	80	91	80	86	88	82
Total Annualized Capital Costs:													
Total/Year (1,000 dollars)	17	81	68	198	24	33	84	79	13	33	29	319	--
Cost/Ton (dollars	.15	2.70	1.82	1.14	.68	.67	.47	.94	.26	.58	.48	1.46	.94
% of Total Cost	2	26	42	13	20	17	20	20	9	20	14	12	18
Total Cost:													
Total/Year (1,000 dollars)	740	316	162	1,492	121	196	415	400	140	162	205	266	--
Cost/Ton (dollars)	6.73	10.52	4.31	8.57	3.46	3.96	2.31	4.81	2.83	2.84	3.40	12.18	5.49

[1] Average for two transfer stations in same community

Table 2. CAPITAL COSTS FOR 12 TRANSFER SYSTEMS IN 1975

Cost Item	Site No. 1	2	3	4	5	6	7	8	9	10	11	12	Average
Land													
Total Cost (1,000 dollars)	--	--	--	--	--	--	--	19	9	20	--	--	--
Site Construction													
Total Cost (1,000 dollars)	118	270	530	2,815	118	0	272	184	9	26	11	125	
Annualized Cost (1,000 dollars)	5.9	27.0	26.5	140.8	5.9	--	13.6	9.2	.4	1.5	.5	12.5	
Cost/Ton (dollars)	.06	.90	.71	.81	.17	--	.08	.11	.01	.03	.01	.05	.24
Stationary Equipment													
Total Cost (1,000 dollars)	6	37	45	865	42	91	189	180	68	22	7	149	
Annualized Cost (1,000 dollars)	.4	3.7	3.0	57.6	3.5	6.1	18.9	9.0	3.4	2.2	.5	14.9	
Cost/Ton (dollars)	.004	.12	.08	.33	.10	.12	.10	.11	.07	.04	.01	.07	.10
Vehicular Equipment													
Total Cost (1,000 dollars)	52	251	194	0	114	200	337	477	45	176	162	1,165	
Annualized Cost (1,000 dollars)	10.4	50.2	38.9	--	14.3	26.9	51.8	60.6	9.0	28.9	27.9	291.4	
Cost/Ton (dollars)	.09	1.68	1.03	--	.41	.55	.29	.72	.18	.51	.46	1.27	.60
Total													
Total Cost (1,000 dollars)	176	558	769	3,680	274	291	798	860	131	244	180	1,439	
Annualized Cost (1,000 dollars)	16.7	80.9	68.4	198.4	23.7	33.0	84.3	78.8	12.8	32.6	28.9	318.8	
Cost/Ton (dollars)	.15	2.70	1.82	1.14	.68	.67	.47	.94	.26	.58	.48	1.39	.94

equipment included equipment required at the transfer station, such as scales, compactors, conveyors, and push pits.

Vehicular Equipment. Vehicle capital costs averaged $.64 per ton for 10 sites which did not lease their equipment, with a range of $.18 to $1.67. Sites 1 and 4 leased their vehicular equipment. The vehicular equipment cost category represented the purchased costs of all vehicles utilized by the transfer operation, including transfer trucks and trailers, sweepers, and front end loaders.

Operating Costs

The average operating cost per ton was $4.55, ranging from $1.84 to $10.72 per ton. This was 82 percent of total annual costs, and ranged from 58 to 98 percent. The annual operating costs of the 12 transfer sites are shown on Table 3 and the operating costs per ton are given in Table 4.

Labor. Labor costs averaged $2.52 per ton and ranged from $.63 to $5.20 per ton. The percentage of labor costs to total operating costs ranged from 26 percent to 81 percent, averaging 55 percent.

Labor costs included salaries, wages and fringe benefits to those individuals employed at the transfer station or directly associated with its operation. These were vehicle drivers, regular, temporary, and overtime pay. An average of $2.10 per ton was attributed to salaries and wages, with a range of $.55 to $4.78 per ton.

Fringe benefit costs included social security, hospitalization, workmen's compensation, and unemployment compensation costs. Fringe benefits averaged $.42 per ton, and ranged from $.63 to $5.20 per ton.

Stationary Equipment. Stationary equipment costs averaged $.18 per ton and ranged from $.01 to $.95 per ton. The stationary equipment operating costs averaged 4 percent of total operating costs. Operating expenses associated with stationary equipment included labor costs for the repair and maintenance of the transfer station equipment and costs of parts and supplies, such as lubricants. Additional costs included were for the purchase of shop equipment, small hand tools, and communication devices.

Vehicular Equipment. Vehicular equipment operating costs were found to average $1.51, ranging from $.41 to $5.07. On the average, 33 percent of the total operating costs were directly associated with vehicular equipment operation, varying from 15 percent to 68 percent. Operating costs associated with the vehicular equipment category included costs of repair and maintenance labor, parts and supplies, and fuel and oil. If the vehicular equipment was rented or leased from a private firm or another municipal agency, the rental costs were also included.

TABLE 3: ANNUAL OPERATING COSTS FOR 12 TRANSFER SYSTEMS IN 1975
(1,000 DOLLARS)

COST ITEM	Site No. 1	2	3	4	5	6	7	8	9	10	11	12
Labor												
Salaries and Wages	385.8	127.6	36.6	239.9	56.5	109.6	160.0	174.0	73.4	31.5	89.6	1,042.0
Fringe Benefits	85.9	31.9	14.6	95.5	9.4	22.1	21.8	22.4	16.9	4.4	21.5	91.0
Total, Labor	471.7	159.5	51.2	335.4	65.9	131.7	181.8	196.4	90.3	35.8	111.1	1,133.0
Stationary Equipment												
Repair and Maintenance	10.6	0	2.1	24.2[1]	1.4	.6[1]	15.3	10.0[1]	.4[1]	1.6[1]	4.5[1]	147.0
Parts and Supplies	23.5	0	.5	--	6.0	--	9.0	--	--	--	--	50.0
Other Equipment Expense	6.4	0	0	--	.3	0	5.5	0	0	0	.8	8.0
Total, Stationary Equipment	40.5	0	2.6	24.2	7.7	.6	29.8	10.0	.4	1.6	5.3	205.0
Vehicular Equipment												
Repair and Maintenance	0	46.8	18.5[1]	0	8.6	17.8[1]	13.2	49.1[1]	17.4	26.7	30.9[1]	327.3
Parts and Supplies	0	12.8	--	0	3.6	--	37.8	--	4.1	12.3	--	387.8
Rental	168.1	0	0	882.3[2]	0	0	2.0	0	1.8	24.7	0	0
Fuel and Oil	21.8	--	4.9	0	2.3	10.0	20.8	26.0	8.7	17.5	6.7	90.0
Total, Vehicular Equipment	189.9	59.6	23.4	882.3	14.5	27.8	73.8	75.1	32.0	81.2	37.6	805.0
Facilities and Site Maintenance	2.0	0	2.1	0	6.0	1.0	5.6	1.6	.6	.2	0	34.3
Utilities	2.1	15.6	7.0	2.9	2.5	1.0	9.0	5.4	1.9	2.9	2.4	77.5
Administrative Expense	9.8	0	0	17.1	.5	.5	19.4	10.8	1.6	1.8	16.1	15.6
Other Expenses	7.5	0	7.2	31.4	.4	0	11.0	21.5	0	5.6	3.8	66.7
Total	723.5	234.7	93.5	1,293.3	97.5	162.6	330.4	320.8	126.8	129.1	176.3	2,337.1

(1) Includes Parts and Supplies.
(2) Includes all Parts and Supplies, Repair and Maintenance, and Fuel and Oil.

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TABLE 4: OPERATING COSTS PER TON FOR 12 TRANSFER SYSTEMS IN 1975
(DOLLARS)

Cost Item	Site No. 1	2	3	4	5	6	7	8	9	10	11	12	Average
Labor													
Salaries and Wages	3.51	4.25	.97	1.38	1.61	2.22	.89	2.10	1.49	.55	1.48	4.78	2.10
Fringe Benefits	.78	1.06	.39	.55	.27	.45	.12	.27	.34	.08	.36	.42	.42
Total, Labor	4.29	5.31	1.36	1.93	1.88	2.67	1.01	2.37	1.83	.63	1.84	5.20	2.52
Stationary Equipment													
Repair and Maintenance	.10	0	.06	.14(1)	.04	.01(2)	.08	.12(1)	.01(1)	.03(1)	.07(1)	.68	
Parts and Supplies	.21	0	.01	-	.17	-	.06	-	-	-	-	.23	
Other Equipment Expense	.06	0	0	0	.007	0	.03	0	0	0	.01	.04	
Total, Stationary Equipment	.37	0	.07	.14	.22	.01	.17	.12	.01	.03	.08	.95	.18
Vehicular Equipment													
Repair and Maintenance	0	1.56	.49(1)	-	.25	.36	.07	.59(1)	.35	.47	.51(1)	1.50	
Parts and Supplies	0	.43	-	-	.10	-	.21	-	.08	.21	-	1.78	
Rental	1.53	0	0	5.07(2)	0	0	.01	0	.04	.43	0	0	
Fuel and Oil	.20	-	.13	-	.07	.20	.12	.31	.17	.31	.11	.41	
Total, Vehicular Equipment	1.73	1.99	.62	5.07	.42	.56	.41	.90	.64	1.42	.62	3.69	1.51
Facilities & Site Maintenance	.02	0	.06	0	.17	.02	.03	.02	.01	.003	0	.16	.04
Utilities	.02	.52	.19	.02	.07	.02	.05	.07	.04	.05	.04	.36	.12
Administrative Expense	.09	0	0	.10	.01	.01	.11	.13	.03	.03	.26	.07	.07
Other Expenses	.06	0	.19	.18	.01	0	.06	.26	0	.09	.06	.31	.10
Total, Operating Cost/Ton	6.58	7.82	2.49	7.43	2.78	3.29	1.84	3.87	2.57	2.26	2.92	10.72	4.55

(1) Includes Parts and Supplies

(2) Includes Parts and Supplies, Repair and Maintenance, and Fuel and Oil

Facilities and Site Maintenance. Facilities and site maintenance averaged $.04 per ton, with a range of $.033 to $.17 per ton. The facilities and site maintenance category included costs for items such as painting, fence or road repair, janitorial services, and rodent control.

Utilities. An average utilities cost of $.12 per ton was found, which varied from $.02 to $.52 per ton. The utilities costs typically included electricity, gas, water, sewer, and telephone charges incurred in the operation of the transfer station facility and all associated equipment.

Administrative Expense. An average of $.07 per ton was reported for administrative expenses in 10 of the sites surveyed, with a range of $.01 to $.26 per ton. Two of the sites did not report any administrative expenses.

Costs associated with the administration of a transfer system may include a variety of expenses which varies with each system. Typically, administrative expenses included those incurred for such items as printing, data processing, postage, paper and forms, uniforms, washroom supplies, non-capitalized office furniture and fixtures, painting, lawn care, and office rental.

Other Expenses. Depending on the individual transfer system, expenses for a number of other items were incurred that were not provided for in the previous categories. These included consulting engineering services, insurance, taxes, and security services. Three of the twelve sites surveyed reported no such expenses, while the remaining nine averaged $.10 per ton, ranging from $.01 to $.31 per ton.

Variations in Cost Elements

Both the capital and operating costs, vary significantly among the 12 transfer system sites. The costs per ton can be influenced by a number of variables such as: (1) tons processed per day; (2) depreciation schedules; (3) wage and fringe benefits rates; (4) hauling costs to the disposal site; and (5) labor utilization.

Tons Processed Per Day. A close relationship between daily tonnage and operating, capital, and total costs per ton was not in evidence. This can be explained, in part, by examining the influence of other factors on the costs per ton. These factors were: (1) start-up operations; (2) operating days per year; (3) purchase vs. rental or lease of equipment; (4) transfer station design.

As table 2 indicates, Site No. 3 had high capital costs. This site operated only six months a year, thus the annualized capital costs per ton were proportionately higher than for sites operating on a 12-month basis.

An examination of the operating costs indicates that Site Nos. 1, 2, 4, and 12 have significantly higher operating costs per ton than the average of $4.55. The major factors influencing these variations were:

(1) Site Nos. 1 and 4 rented or leased the majority of their vehicular equipment. This resulted in higher operating costs per ton.

(2) Some sites were based on six months of initial operation and may not be representative of normal operating costs.

(3) Site No. 12 utilized an existing incinerator facility for one of its two transfer stations. This station was not equipped with push pits and compactors, but transferred waste by means of clam shell cranes. This was a more expensive, time-consuming operation.

Depreciation Schedules. Examination of the depreciation schedules, shown in Table 5, reveals that all sites did not depreciate their facilities and capital equipment in the same manner. Most sites depreciated their facilities over 20 years, stationary equipment over 10 to 15 years, and vehicular equipment over 5 years.

Depreciation for each transfer system was computed on a straight-line basis. Although the depreciation period influences the annualized capital cost, the data did not support a statement concerning this relationship, since capital costs varied from site to site and depreciation periods did not differ substantially among most of the sites.

Wage and Fringe Benefits Rates. Average hourly wages of the transfer systems' employees are displayed in Table 6. Supervisors had an average hourly wage of $6.51; station employees, $4.72; and vehicle operators $4.98.

These rates help explain some of the operating cost per ton variations shown in Table 4. For example, Site No. 10, which had the lowest average hourly wages, had much lower operating costs per ton than sites with similar daily tonnages. Site No. 1, which had the highest wage rates also had high operating costs per ton.

The fringe benefits rates averaged 20 percent of salaries and wages, with a range of 9 to 40 percent. There is a direct relationship between labor costs and fringe benefits rates since fringe benefits are calculated by multiplying the cost of salaries and wages by the fringe benefits percentage.

TABLE 5

DEPRECIATION PERIODS FOR 12 TRANSFER SYSTEMS IN 1975

Site No.	Site Construction	Stationary Equipment	Vehicular Equipment
1	20	15	5
2	10	10	5
3	20	15	5
4	20	15	--
5	20	12	8
6	--	15	3-5
7	20	10	6
8	20	20	10
9	20	20	5
10	16	10	3-5
11	20	14	6
12	10	10	4
Average	20	10-15	5

TABLE 6

WAGE RATES AND FRINGE BENEFITS RATES FOR 12 TRANSFER SYSTEMS IN 1975

Site No.	Supervisor Avg. Hourly Wage	Station Employee Avg. Hourly Wage	Vehicle Operator Avg. Hourly Wage	Fringe Benefits Rate
1	$8.75	$6.06	$6.68	22%
2	6.48	5.47	5.41	25
3	7.47	5.90	5.83	40
4	--	--	--	40
5	6.48	5.38	5.66	16
6	--	4.16	4.75	20
7	--	4.30	4.60	14
8	4.50	3.50	3.80	13
9	6.87	4.35	5.00	23
10	4.00	2.10	2.10	14
11	6.46	5.46	5.30	24
12	7.56	5.26	5.71	9
Average	6.51	4.72	4.98	20

Hauling Costs. The largest cost item in any transfer operation is hauling to the landfill. As shown on Table 7, costs increase almost in direct relation to distance hauled. Average costs for 10 firms reporting were $2.82 per ton for an average round trip haul of 31 miles or about 9 cents per ton mile. On a mile basis truck operating costs, including labor and depreciation, were $1.36 for a 15 ton load.

It is difficult to establish a typical tractor trailer operating cost. Some communities were confronted with severe traffic conditions and poor roads while others had only 1-2 traffic lights and interstate highways. Other communities incurred high maintenance costs because transmissions and axles broke down on sandy landfills. Some communities were able to purchase used tractors and thru good maintenance keep operating costs at a minimum.

Labor Utilization. There was considerable variation among transfer stations on tons handled per employee on an 8 hour day. As shown on Table 8, tons per station employee per day ranged from 20 to 120 tons and tons per supervisor ranged from 50 to 2900 a day. A valid comparison of tons per vehicle driver cannot be made because road and traffic conditions have a strong effect on productivity.

Several factors contribute to the large variation. Some stations desired a big crew for peak periods, others maintained extensive cleanup crews or employees to help collection trucks unload. The most effective arrangement appeared to be the switching of jobs among all employees. For example, everyone concentrated on unloading trucks or getting waste thru the compactors into transfer trucks and then everyone helped with cleanup. In some instances, drivers and station personnel switched jobs on a 4 hour basis. One labor saving method was to have the scaler assign each truck to an unloading bay thus avoiding a spatter on the dumping floor. Other stations reduced labor requirements by presetting the compactors for a select number of cycles and not weighing trucks after loading. Some stations required drivers to open and close tailgates and run the compactors while other firms had separate specialized personnel for these operations.

The number of supervisors to a station had a considerable variation. In general, one man is sufficient for most facilities. Some larger stations had a supervisor for maintenance and fleet operation, in addition to station operation which can increase costs substantially. Other station's used working foremen to operate the facility and the supervisor only spent part of the day at the station and managed the landfill or collection vehicles in addition to his transfer station duties.

TABLE 7: DIRECT HAULING COSTS FOR 12 TRANSFER SYSTEMS IN 1975

Item	Site No. 1	2	3	4	5	6	7	8	9	10	11	12	Average
Characteristic													
Round Trip Distance to Landfill (Miles)	40	63	22	0	20	23	35	45	27	25	20	50/56	
Number of Trips/Day	30	8	(1)	(1)	6	(1)	(1)	14	9	(1)	15	65	
Miles/year (1,000) 2/	315	126	--	--	40	--	--	229	74	--	91	930	
Tons/Year (1,000) 2/	110	30	38	174	35	49	180	83	42	57	60	229	
Direct Hauling Cost/Ton (dollars) 3/													
Operating Cost/Ton	3.96	(1)	1.22	(1)	1.03	1.93	.98	2.11	1.60	1.77	1.94	6.44	2.30
Capital Cost/Ton	.09	--	.94	--	.41	.55	.28	69	.12	.40	.36	1.34	.52
Total Cost/Ton	4.05	--	2.16	--	1.44	2.48	1.26	2.80	1.72	2.17	2.30	7.78	2.82
Direct Hauling Cost/Mile (dollars) 3/													
Operating Cost/Mile	1.38	(1)	(1)	(1)	.90	(1)	(1)	.76	1.07	(1)	1.29	1.51	1.15
Capital Cost/Mile	.04	--	--	--	.36	--	--	.25	.08	--	.24	.31	.21
Total Cost/Mile	1.42	--	--	--	1.26	--	--	1.01	1.15	--	1.53	1.82	1.36

(1) Data not available.
(2) Rounded.
(3) Includes drivers' wages, maintenance, parts and supplies.

TABLE 8: AVERAGE DAILY TONS FOR TRANSFER SYSTEM PERSONNEL

Site No.	Tons/Day	No. of Supervisors	Tons/ Supervisor	No. of Station Employees	Tons/ Station Employee	No. of Vehicle Operators	Tons/ Vehicle Operator
1	387	1	387	11	35	15	26
2	120	1	120	3	40	4	30
3	289	.1	2,899	4	72	3	96
4	670	1	670	7	96	0	-
5	112	.5	224	1	112	4	28
6	190	1	190	2	95	4	48
7	600	1	600	5	120	7	86
8	228	2	114	7	33	8	28
9	155	.5	310	3	52	3	52
10	220	1	220	4	55	4	55
11	200	4	50	10	20	5	40
12	880	9	98	44	20	45	20
Average			489		62		46
Range			50-2,899		20-120		20-96

Cost Estimating

This section presents procedures for developing estimates of the capital and operating costs of a transfer system. These estimates are not intended to replace estimates as part of a detailed engineering design study for a particular transfer station. When available, current local cost data should be utilized with the procedures.

Capital Costs. Costs for the following categories should be developed in estimating capital costs.

(1) Land. Transfer stations generally require a minimum of two acres of land. Also, if cost savings are to be maximized from the operation of the transfer system, it is important that the transfer stations be located near to collection routes. Because of the variation in the cost of land, local land costs should be utilized in estimating the costs in this category.

Estimated land cost. . . . . ._____

(2) Site construction. Site construction costs, including site preparation and development costs, vary greatly depending on the condition of the land and the type of structure proposed. In addition, site construction costs will be affected by the availability of existing structures which can be modified for use as a transfer station. For example, conversion of an incinerator facility can reduce construction costs by as much as 75 percent.

For estimating purposes, $97,000 per 100 tons of daily capacity can be used, based on the site construction capital costs for five of the surveyed sites with enclosed transfer stations.

The annualized site construction capital costs may be computed by dividing the estimated site construction cost less the anticipated salvage value by the depreciation period in years. Most of the surveyed transfer systems used a depreciation period of 20 years.

Estimated site construction cost. . . . . .(total) _____
(annualized) _____

(3) Stationary equipment. Transfer system stationary equipment typically can include scales, hoppers, compactors, and push pits. In general, the installation of one or two stationary compactors is recommended for transfer stations handling up to 200 tons per day.

The surveyed sites had an average total stationary equipment capital cost of $170,000. Except for one location, the sites transferring under 225 tons per day had costs under $100,000.

For estimating purposes, $57,000 per 100 tons of daily capacity may be utilized, based on the surveyed sites.

Annualized stationary equipment capital costs may be calculated using a depreciation period in the 10 to 15 year range, based on the survey findings.

Estimated stationary equipment costs . . . . . (total) _____
(annualized) _____

(4) Vehicular Equipment. Vehicular equipment used in a truck transfer system can be of two general types: equipment used to haul the solid waste from the transfer station to the disposal site or equipment used at the station itself.

The number and type of tractor/trailers required in a truck transfer system depend upon the volume of refuse and the time and distance to the disposal site.

The number of tractor/trailers required may be estimated as follows:

- Step 1: Number of Daily Tractor/Trailer Loads. To determine the number of tractor/trailer loads required each day, the daily tonnage can be divided by the average trailer load weight of 15 tons.

- Step 2: Average Time Required for Each Round Trip. To estimate the time required to transport each load, multiply the roundtrip mileage by an average 2.7 minutes per mile. An estimated time for loading, such as 15 minutes, must then be added.

- Step 3: Possible Number of Loads Per Tractor/Trailer Per Day. To estimate the maximum number of loads which can be transported by a single tractor/trailer in a day, divide the number of working hours in a day by the average time required for each round trip determined in Step 2.

- Step 4: Number of Tractor/Trailers Required. To estimate the total number of tractor/trailers required, divide the total number of loads required per day (Step 1) by the number of loads per tractor/trailer per day (Step 3), and then add any reserve tractor/trailers.

After the number of tractor/trailers has been determined, the total costs for transfer vehicles can be calculated by multiplying the number by current local vehicle prices. Tractor/trailer costs averaged $42,500 for the surveyed sites.

In addition, this category includes vehicular equipment used at the station such as front end loaders, sweepers, yard tractors, back hoes, and other similar equipment. If the exact requirements are not known, $11,600 per 100 tons of daily capacity may be used to estimate this item.

In computing the annualized capital costs for vehicular equipment, five years can be assumed as the depreciation period.

Estimated vehicular equipment costs . . . . . .(total) _____
(annualized) _____

Operating Costs. Annual operating costs may be estimated by developing costs for the following categories.

(1) Labor. This category consists of costs for salaries and wages and fringe benefits. Three types of personnel generally are employed in a transfer system: supervisors, station employees, and vehicle operators. The salaries and wages cost can be calculated as follows:

Number of personnel by job category	x Hourly wage for job category	x Hours worked per day	x Days of operation per year

Table 8 shows a breakdown of the number of tons per day per employee for the surveyed sites in each of three categories: supervisor, station employee, and vehicle operator. Based on these figures, the following averages can be used for estimating purposes:

- Supervisors--.06 supervisors per 100 tons
- Station employees--3 employees per 100 tons
- Vehicle operators--3 operators per 100 tons

Using these averages, the number of employees by job category may be estimated by multiplying the average tons per day by employees per ton.

Local hourly wage rates should be used in determining salaries and wages costs. If these are not available, the following average hourly wage rates may be used: supervisor, $6.51; station employee, $4.72; and vehicle operator, $4.98.

The costs of fringe benefits may be developed by multiplying the local fringe benefits rate by the cost of salaries and wages. If local rates are not available, an average rate of 20 percent may be used.

Estimated salaries and wages cost . . . . . ._____
Estimated fringe benefits cost . . . . . ._____

(2) Stationary equipment. Operating costs associated with stationary equipment primarily include those for repair and maintenance and parts and supplies. The purchase of non-capitalized equipment such as hand tools and shop equipment is also included. Stationary equipment operating costs may be estimated using an average cost of $.20 per ton.

Estimated stationary equipment cost . . . . . .____

(3) Vehicular equipment. The operating costs for vehicular equipment include those for repair and maintenance, parts and supplies, fuel and oil, and rental. An average cost of $.54 per ton, or $.50 per mile, as shown in Table 11, can be used to estimate these costs for systems purchasing most of their vehicular equipment. If desired, a more detailed estimate may be developed as described below.

Since costs for repair and maintenance, and parts and supplies generally are related to usage, these costs can be estimated on the basis of the total number of hours of operation per year. The following steps may be followed in estimating these costs, using an average cost per hour of $9.54:

Daily transportation hours	=	Number of daily tractor/trailer loads	x	Average time for each round trip
Annual transportation hours	=	Daily transportation hours	x	Operating days per year
Annual repair and maintenance and parts and supplies cost	=	Annual transportation hours	x	Cost per hour ($9.54)

Annual fuel and oil costs can be estimated on the basis of the miles traveled. An average of $.11 per mile may be used for estimating fuel and oil costs. Annual costs may be determined from the number of daily tractor loads, as estimated previously, and the round-trip-mileage between the transfer station and the disposal area.

Costs for rented equipment should be based on current local rates.

Estimated vehicular equipment costs . . . . . ._____

(4) Facilities and site maintenance. The average cost of $.05 per ton may be used to estimate these costs.

Estimated facilities and site maintenance cost. . . . . _____

(5) Utilities. Utilities costs may be estimated using an average of $.12 per ton.

Estimated utilities cost. . . . . ._____

(6) Administrative expense. This expense can be computed on the basis of an average of $.08 per ton.

(7) Other Expenses. A provision for other expenses may be made, if required, by using an average of $.10 per ton.

Estimated administrative expense. . . . . .____

Tables 9 and 10 may be used in developing capital and operating cost estimates for transfer systems.

TABLE 9

TRANSFER SYSTEM CAPITAL COST WORKSHEET

1	2	3	4	5	6	7	8
Cost Category	Typical Items Included	Capital Cost	Depreciation Period	Annualized Cost	Cost/Ton	Survey Cost Ton Average $	Survey Cost Ton Range $
Land	Survey, legal, land cost						
Site Construction	Planning and designing, site preparation, demolition, grading, facilities construction, fencing, road construction					.24	.01-.90
Stationary Equipment	Scales, push pits, compactors					.10	.004-.33
Vehicular Equipment	Tractors, trailers, loaders					.60	.09-1.67
Other Equipment	Office equipment, maintenance equipment (compressors, etc.)					-	-
Totals	--		--			.94	.15-2.70

TABLE 10

TRANSFER SYSTEM OPERATING COST WORKSHEET

1	2	3	4	5	6
Cost Category	Typical Items Included	Annual Cost	Cost/Ton	Survey Cost/Ton Average ($)	Survey Cost/Ton Range ($)
Labor - Salaries and Wages	Regular, temporary, and overtime compensation to employees, e.g., supervisors, scalemen, equipment operators, vehicle drivers			2.10	.55-4.78
Labor - Fringe Benefits	Workmen's Compensation, FICA, employee hospital, life, and dental insurance, retirement			.42	.08-1.66
Stationary Equipment	Repair and maintenance (in-house and contracted) parts and supplies, shop equipment purchases (non-capitalized)			.18	.01- .95
Vehicular Equipment	Repair and maintenance (in-house and contracted) parts and supplies, rental, fuel, and oil			1.51	.41-5.07
Facilities and Site Maintenance	Maintenance services (in-house or contracted), janitorial services, building and road materials, paint, fencing, plumbing supplies			.04	.003- .17
Utilities	Water, gas, electricity, sewer, telephone			.12	.02- .52
Administrative Expense	Office supplies, uniforms and cleaning, training, printing, postage, books, accounting services, data processing, legal services			.07	.01- .26
Other Expenses	Consulting and engineering services, liability insurance, security services			.10	.01- .31
Totals	---			4.55	1.84-10.72

SHREDDING

Shredding is a solid waste volume reduction process often referred to as milling, grinding, or pulverizing. Shredded waste either may be directly landfilled or used in combination with other processes, such as pyrolysis or materials recovery.

Advantages of shredding are: (a) the life of a landfill can be extended since shredding reduces the volume of the solid waste; (b) daily cover of shredded solid waste may not be required; (c) shredded waste is easier to compact saving labor and equipment expense; (d) shredding reduces paper blowing and the fire potential; and (e) shredded waste does not attract vermin.

Disadvantage is the fact that shredding involves an additional processing step over landfilling, and additional operating and capital costs are incurred.

The characteristics of the 10 shredder systems that were surveyed are presented in Table 11. The sites varied from 64 to 1,042 average tons per day of operation.

The annual operating costs and the annualized capital costs for the 10 shredder sites are summarized in Table 11. The sites had an average operating cost per ton of $5.61 and an average annualized capital cost per ton of $1.69, resulting in a total cost per ton of $7.30. The operating costs averaged 77 percent of total costs. All costs reflect the operation of the shredder facility itself and the transportation of the shredded waste to a landfill.

Capital Costs

Capital costs are presented in Table 12. The annualized capital cost per ton for the shredder sites varied from $.80 to $3.10, and averaged $1.69. Capital costs for the shredder sites were collected in five major categories: land, site construction, stationary equipment, vehicular equipment, and other equipment. Annualized capital costs were calculated for each cost category, except for land, which was assumed to have infinite life. Annualized capital costs per ton for the 10 sites averaged 23 percent of total costs per ton, ranging from 14 percent to 36 percent.

Land. The land utilized by the shredder sites varied from 2 to 20 acres. For the five sites where data were available, the cost per acre ranged from $1,000 to $16,000. All five sites had purchased their land.

TABLE 11

CHARACTERISTICS AND COSTS OF 10 SHREDDER SITES IN 1975

Characteristics	Site No. 1	2	3	4	5	6	7	8	9	10	Average
Average Tons/Day Processed	800	197	712	1,042	114	168	176	225	312	6-	
Tons/Year Processed	204,800	61,000	185,000	270,293	29,293	43,680	45,680	58,479	81,244	17,860	
Days/Year of Operation	256	310	260	260	258	260	260	260	260	280	
Number of Shredders	3	2	3	5	2	1	2	1	3	2	
Shredder Type/Capacity (TPH)	Vert/40 Vert/20	Hor/40	Hor/60	Vert/40 Vert/15	Vert/20 Vert/15	Vert/40	Hor/15 Vert/9	Hor/50	Vert/40	Vert/25	
Site Acreage	3	20	7.5	--	4	4	4	6	6.5	2.1	
Storage Capacity (Tons)	100	0	--	1,000	.4	336	.5	225	0	0	
Resultant Particle Size (Inches)	4	4	3	3	1.5	4.5	3	--	3	3.5	
Roundtrip Distance to Landfill (Miles)	0	--	--	--	--	0	--	--	--	0	
Number of Shifts	2	1	1	2	1	1	2	1	2	1	
Number of Supervisors	3	2	3	4	1	1	1	1.5	3	1	
Number of Site Employees	27	14	22	35	4	5	5	4	13	5	
Number of Vehicle Operators	6	3	10	9	1	2	3	3	4	1	
Total Operating Costs:											
Total/Year (1,000 dollars)	584	580	942	1,080	169	215	226	201	541	144	--
Cost/Ton (dollars)	2.85	9.50	5.09	3.99	5.77	4.92	5.84	3.44	6.66	8.07	5.61
% of Total Cost	73	82	75	83	80	82	86	64	68	74	77
Total Annualized Capital Costs:											
Total/Year (1,000 dollars)											
Cost/Ton (dollars)	1.05	2.04	1.67	.80	1.41	1.11	.98	1.92	3.10	2.80	1.69
% of Total Cost	27	18	25	17	20	18	14	36	32	26	23
Total Cost:											
Total/Year (1,000 dollars)	798	705	1,252	1,296	210	263	311	313	793	19-	--
Cost/Ton (dollars)	3.91	11.54	6.77	7.18	6.03	6.82	5.36	9.75	9.75	10.88	7.30

22

TABLE 12

CAPITAL COSTS OF 10 SHREDDER SITES IN 1975

Cost Item	Site No. 1	2	3	4	5	6	7	8	9	10	Average
Land											
Total Cost (1,000 dollars)	48	19	45	--	--	--	--	--	20	7	
Site Construction											
Total Cost (1,000 dollars)	178	570	3,323	824	251	373	283	500	1,976	499	
Annualized Cost (1,000 dollars)	10.5	28.5	107.4	41.2	7.5	18.7	14.2	33.3	131.8	27.7	
Cost/Ton (dollars)	.05	.47	.58	.15	.26	.43	.31	.57	1.62	1.55	.60
Stationary Equipment											
Total Cost (1,000 dollars)	2,076	1,107	1,465	883	404	225	240	850	530	331	
Annualized Cost (1,000 dollars)	122.1	55.3	97.7	58.9	20.2	15.0	16.0	56.7	35.3	18.4	
Cost/Ton (dollars)	.60	.91	.53	.22	.69	.34	.35	.97	.44	1.03	.51
Vehicular Equipment											
Total Cost (1,000 dollars)	246	203	522	574	86	102	116	187	369	13	
Annualized Cost (1,000 dollars)	82.0	40.7	104.5	116.0	13.3	14.8	14.6	22.1	73.6	2.5	
Cost/Ton (dollars)	.40	.67	.56	.43	.46	.34	.32	.38	.91	.14	.46
Other Equipment											
Total Cost (1,000 dollars)	0	2	0	0	5	0	0	1	55	3	
Annualized Cost (1,000 dollars)	0	.2	0	0	.3	0	0	.1	11.0	.1	
Cost/Ton (dollars)	0	.003	0	0	.01	0	0	.002	.14	.01	.02
Total											
Total Cost (1,000 dollars)	2,549	1,900	5,256	2,284	746	700	640	1,538	2,949	877	
Annualized Cost (1,000 dollars)	214.6	124.7	309.6	216.0	41.3	48.4	44.7	112.2	251.7	50.1	
Cost/Ton (dollars)	1.05	2.04	1.67	.80	1.41	1.11	.98	1.92	3.10	2.80	1.69

Site Construction. Site construction costs for the shredder sites varied from $.05 to $1.62 per ton, with an average of $.60. Site construction costs were defined to include: planning and designing costs; site development costs, including site preparation, roadways; fencing, and water lines; and all construction costs for shredder facilities and associated buildings.

Stationary Equipment. The cost per ton of stationary equipment for the shredder sites averaged $.61, and varied from $.22 to $1.03. Stationary equipment costs included all fixed equipment purchased for a shredder site, such as shredding machinery, scales, conveyors, and stationary packers.

Vehicular Equipment. Vehicular equipment costs for the shredder sites varied between $.02 and $.91 per ton, and averaged $.46. Vehicular equipment capital costs were the costs of all purchased vehicles associated with the shredder operation. Typically, these vehicles included transfer trucks and trailers, front end loaders, dump trucks sweepers, cranes, dozers, and pickup trucks.

Other Equipment. Where other equipment costs were reported, the cost per ton for shredder sites ranged from $.002 to $.14, with an average of $.02. Other equipment capital costs included the costs of all other purchased equipment that is capitalized and not provided for within the site construction, stationary equipment, or vehicular equipment cost categories. Items in the other equipment category included office equipment and maintenance equipment, such as welding equipment and compressors.

Operating Costs

Total operating costs per ton for the surveyed shredder sites averaged $5.61, ranging from $2.85 to $9.50 per ton. Operating costs averaged 77 percent of total annual costs, ranging from 64 percent to 86 percent. Annual operating costs, excluding annualized capital costs, for the shredder sites are presented in Table 13. The operating costs are grouped into seven major categories: labor, stationary equipment, vehicular equipment, facilities and site maintenance utilities, administrative expenses, and other expenses. Operating cost per ton figures are displayed in Table 14.

Labor. Total labor cost per ton, including salaries and wages and fringe benefits, for the shredder sites ranged from $1.30 to $4.68, with an average of $2.21. Labor costs amounted to an average of 98 percent of total operating costs, ranging from 24 percent to 49 percent.

The labor cost category is composed of both salaries and wages and fringe benefits costs. The salaries and wages cost provides for

TABLE 13

OPERATING COSTS OF 10 SHREDDER SITES IN 1975
(1,000 DOLLARS)

Cost Item	Site No. 1	2	3	4	5	6	7	8	9	10
Labor										
Salaries and Wages	236.5	216.3	293.4	389.7	49.0	54.6	82.0	80.4	83.8	49.4
Fringe Benefits	31.3	69.0	57.2	74.0	8.5	6.6	27.1	14.9	36.1	13.9
Total, Labor	267.8	285.3	350.6	463.7	57.5	61.3	109.0	95.3	120.9	63.3
Stationary Equipment										
Repair and Maintenance	142.9	77.6	56.0	214.8	32.2	26.5	36.4	40.0	135.4	6.1
Parts and Supplies	(1)	3.9	65.0	217.4	35.8	30.9	56.1	(1)	73.4	2.7
Other Equipment Expense	.3	0	0	16.1	.7	7.8	0	.7	10.3	18.5
Total, Stationary Equipment	143.2	81.5	121.0	448.3	68.7	65.2	92.5	40.7	219.6	27.3
Vehicular Equipment										
Repair and Maintenance	100.8	70.6	299.0	77.1	1.8	10.9	11.6	.5	34.0	1.0
Parts and Supplies	(1)	3.8	(1)	(1)	1.1	16.1	12.2	(1)	4.2	1.9
Rental	0	18.5	0	.9	6.0	10.0	8.3	47.0	0	0
Fuel and Oil	(1)	3.9	(1)	(1)	2.6	4.6	13.4	(3)	5.1	7.5
Total, Vehicular Equipment	100.8	96.7	299.0	78.0	11.5	41.6	45.6	47.5	43.3	10.1
Facilities and Site Maintenance	4.4	10.1	0	5.7	9.9	10.6	0	2.3	5.4	0
Utilities										
Electricity	47.7	43.8	171.0	67.6	8.5	14.4	16.5	(4)	39.5	32.0
Other	8.2	18.0	.4	3.4	5.2	.4	3.3	(4)	18.6	3.0
Total, Utilities	55.9	61.8	171.4	70.9	13.7	14.7	19.7	9.8	58.1	35.0
Administrative Expense	9.2	12.2	.4	14.5	4.0	3.8	0	5.4	21.0	7.1
Other	3.0	31.9	0	0	3.7	17.9	0	.3	62.3	.9
Total	584.2	579.6	942.4	1,080.2	168.9	215.0	266.9	201.2	543.7	144.2

(1) Included in Repair and Maintenance
(2) Includes Gas
(3) Included in Rental
(4) Not available

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TABLE 14

OPERATING COSTS PER TON OF 10 SHREDDER SITES IN 1975
(DOLLARS)

Cost Item	Site No. 1	2	3	4	5	6	7	8	9	10	Average
Labor											
Salaries and Wages	1.16	3.55	1.59	1.44	1.67	1.25	1.79	1.38	1.16	2.77	1.77
Fringe Benefits	.15	1.13	.31	.27	.29	.15	.59	.25	.44	.78	.44
Total, Labor	1.31	4.68	1.90	1.71	1.96	1.40	2.39	1.63	1.60	3.54	2.21
Stationary Equipment											
Repair and Maintenance	.70	1.27	.30	.79	1.10	.61	.80	.68	1.67	.34	
Parts and Supplies	(1)	.06	.35	.80	1.22	.71	1.23	0	.90	.15	
Other Equipment Expense	.002	0	0	.06	.02	.18	0	.01	.13	1.06	
Total, Stationary Equipment	.70	1.34	.65	1.65	2.35	1.49	2.02	.70	2.70	1.56	1.52
Vehicular Equipment											
Repair and Maintenance	.49	1.16	1.62	.29	.06	.25	.26	.01	.42	.06	
Parts and Supplies	(1)	.06	(1)	(1)	.04	.37	.27	(1)	.05	.09	
Rental	0	.30	0	.003	.20	.23	.18	.80	0	0	
Fuel and Oil	(1)	.06	(1)	(1)	.09	.10	.29	(3)	.06	.42	
Total, Vehicular Equipment	.49	1.58	1.62	.29	.39	.95	1.00	.81	.53	.57	.82
Facilities and Site Maintenance	.02	.17	0	.02	.34	.24	0	.04	.07	0	.09
Utilities											
Electricity	.23(2)	.72	.92	.25	.29	.33	.36	(4)	.49	1.79	
Other	.04	.30	.002	.01	.18	.01	.07	(4)	.23	.17	
Total, Utilities	.27	1.01	.93	.26	.47	.34	.43	.17	.72	1.96	.66
Administrative Expense	.04	.20	.002	.05	.14	.09	0	.09	.26	.40	.13
Other Expenses	.02	.52	0	0	.13	.41	0	.01	.77	.05	.19
Total	2.85	9.50	5.09	3.99	5.77	4.92	5.84	3.44	6.66	8.07	5.61

(1) Included in Repair and Maintenance.
(2) Includes gas.
(3) Included in Rental.
(4) Not available.

regular, temporary, and overtime compensation paid to personnel directly involved with the plant operation. Employees typically included were supervisors, equipment operators, pit loader operators, laborers, transfer truck drivers, and scalemen. Salaries and wages averaged $1.77 per ton, ranging from $1.15 to $3.55 per ton.

Fringe benefits provide for those costs incurred for workmen's compensation; social security; employee hospital, dental, and life insurance; retirement; and other benefits not paid for by the employee. Fringe benefits ranged from $.15 to $1.13 per ton, averaging $.44 per ton.

Stationary Equipment. Stationary equipment costs per ton averaged $1.52, ranging from $.65 to $2.70. Stationary operating costs averaged 27 percent of total operating costs, ranging from 13 percent to 42 percent.

The stationary equipment cost category is composed of those costs associated with the repair and maintenance, including parts and supplies of all fixed equipment at the shredder facility, such as the shredders and conveyors. The repair and maintenance cost element represents the labor costs for work performed by shredder facility personnel, such as maintenance personnel and welders, or fees paid to private firms or to other organizational units. Parts and supplies include replacement and maintenance items associated with the stationary equipment, such as hammers and lubricants. The stationary equipment category also includes other equipment expenses incurred for non-capitalized equipment. The other equipment expense cost element provides for miscellaneous items such as shop supplies, welding supplies, and hand tools.

All shredders surveyed had extensive repair and maintenance facilities. In many cases, the parts inventory was valued at $50,000 to $100,000.

Vehicular Equipment. Vehicular equipment operating cost per ton averaged $.82 and had a range from $.29 to $1.62. The average percentage of vehicular equipment operating costs to total operating costs was 15 percent, ranging from 7 percent to 32 percent.

Vehicular equipment costs include those expenses incurred for the repair and maintenance, parts and supplies, rental, and fuel and oil for vehicles. Repair and maintenance costs generally represent labor charges by other organizational units or by private contractors, but also include labor costs for major vehicular repairs and maintenance acitivities when done on a full-time or part-time basis by personnel assigned to the shredder facility. Parts and supplies include all replacement and maintenance items utilized for the vehicles, such as batteries, tires, and lubricants. Rental provides for all expenses incurred when vehicular

equipment is rented or leased from another organizational unit or from a private firm. Fuel and oil includes those costs for gasoline, diesel fuel, and motor oil used in the operation of the vehicular equipment.

Facilities and Site Maintenance. The cost per ton averaged $.01 and ranged from zero to $.34 per ton. Costs included in the facilities and site maintenance category are the labor and materials expenses incurred in maintaining the structures and grounds at the shredder site. Typical costs are in-house or contracted maintenance and janitorial services, building materials, road materials, paint, and plumbing supplies.

Utilities. The total utilities cost averaged $.66 per ton, and ranged from $.17 to $1.96 per ton. The utilities cost category provides for the electricity, water, gas, sewer, and telephone expenses incurred in the operation of the shredder facility.

Administrative Expense. Administrative expense averaged $.13 per ton and ranged from zero to $.40 per ton. The administrative expense category provides for general operating expenses directly incurred by the shredder facility. Included are costs for office supplies, uniforms and foul weather gear, travel, training, printing postage, books and subscriptions, legal and accounting services, and data processing.

Other Expenses. The cost per ton for other expenses ranged as high as $.77, although the average was $.19 per ton. Costs included in this category are for those items not provided for in the previous cost categories. For example, the costs of consulting engineering services, liability insurance, and security services are considered to be in this category.

Variations in Costs

Wide variations in costs were observed among the sites visited. In general, the variations were attributable to (1) tons processed per day; (2) depreciations schedules; (3) equipment utilization; (4) wage and fringe benefits rates; (5) distance to landfill or processing area.

Tons Processed Per Day. In general, the costs per ton decrease with increasing tons processed per day. For shredder sites under 500 tons per day, the average total cost per ton was $8.17 compared with $5.15 for sites over 500 tons per day. Operating and capital costs per ton follow the total cost per ton closely, as would be expected.

The percentage of capital cost to total cost remained essentially the same with increasing tons processed per day, as given in Table 11. Shredder sites with less than 500 tons per day and sites over 500 tons per day both averaged 23 percent.

Depreciation Schedules. The total annualized capital cost and the capital cost per ton is affected by the depreciation method and period

TABLE 15

DEPRECIATION PERIODS FOR 10 SHREDDER SITES
(YEARS)

Site No.	Site Construction	Stationary Equipment	Vehicular Equipment
1	17	17	3
2	20	20	5
3	20	15	6
4	20	15	3-5
5	20-35	20	5-10
6	20	15	3-8
7	20	15	8-15
8	15	15	5-10
9	15	15	5
10	18	10	5
Mode	20	15	5

TABLE 16

WAGE RATES AND FRINGE BENEFITS RATES
FOR 10 SHREDDER SITES IN 1975

Site No.	Supervisor Avg. Hourly Wage	Site Employee Avg. Hourly Wage	Vehicle Operator Avg. Hourly Wage	Fringe Benefits Rate
1	$4.61	$2.71	$3.06	13%
2	5.77	3.32	6.76	32
3	7.83	5.61	5.66	20
4	5.00	3.90	4.31	19
5	6.52	5.80	5.55	17
6	4.28	3.61	3.72	12
7	6.59	5.37	5.08	33
8	--	--	--	18
9	5.50	4.40	4.20	38
10	5.00	4.20	4.20	28
Average	5.68	4.32	4.73	23

utilized for the facilities, stationary equipment, and vehicular equipment of a shredder site. Depreciation for all shredder sites was calculated on a straight-line basis, using the depreciation period being utilized by the particular site. Table 15 shows the depreciation periods of items within the site construction, stationary equipment, and vehicular equipment capital cost categories utilized by the various sites. The most common depreciation period for site construction was 20 years; stationary equipment, 15 years; and vehicular equipment, 5 years.

Utilization Ratio. The effect of the utilization ratio, or the average tons processed per day to the tons of daily design capacity, on the total cost per ton of shredders is shown in Figure 1. In general, as the utilization increases, there is a corresponding decrease in the total cost per ton. The range of the utilization for the shredder sites was from 16 percent to 62.5 percent with half of the sites falling between 45.5 percent and 56 percent. Variations in the utilization percentages can be attributed, in part, to differences in the system design requirements or the equipment performance. One reason for a number of the low utilization ratios was that many shredder sites reported a lower than normal solid waste volume during the period of operation examined.

Wage and Fringe Benefits Rates. The wage and fringe benefits rates directly affect the labor cost portion of operating costs of a site. The average hourly wage rates for supervisor, site employee, and vehicle operator personnel for each of the shredder sites are presented in Table 16. Table 16 also gives the fringe benefits rates by site. The supervisor average hourly rate averaged $5.68, ranging between $4.28 and $7.83. Site employees averaged $4.32 per hour and ranged from $2.71 to $5.80 per hour. Vehicle operators averaged $4.73 per hour, varying from $3.06 to $6.76 per hour. The percentage of fringe benefits to the total salaries and wages ranged from 12 percent to 38 percent, with an average of 23 percent.

Distance to Landfill or Processing Area. The distance between the shredder site and a landfill or an area where other processing occurs affects the total operating and capital costs per ton. The round-trip distance for the shredder sites varied between zero and 35 miles. The direct hauling costs per ton and the round-trip distance for the shredder sites are presented in Table 17. The total direct hauling costs averaged $1.47 per ton, ranging from $.67 to $2.53 per ton.

Cost Estimating

There are many differences in the designs and operations of shredder sites and this is reflected in the operating and capital costs. The cost differences may be due to the factors discussed in the previous section, such as volume, degree of utilization, local wage and fringe benefits rates, and distance to a landfill or processing area. Differences may also be attributable to other factors, such as equipment performance and site design.

FIGURE 1 TOTAL COST PER TON VS. UTILIZATION FOR 10 SHREDDER SITES IN 1975

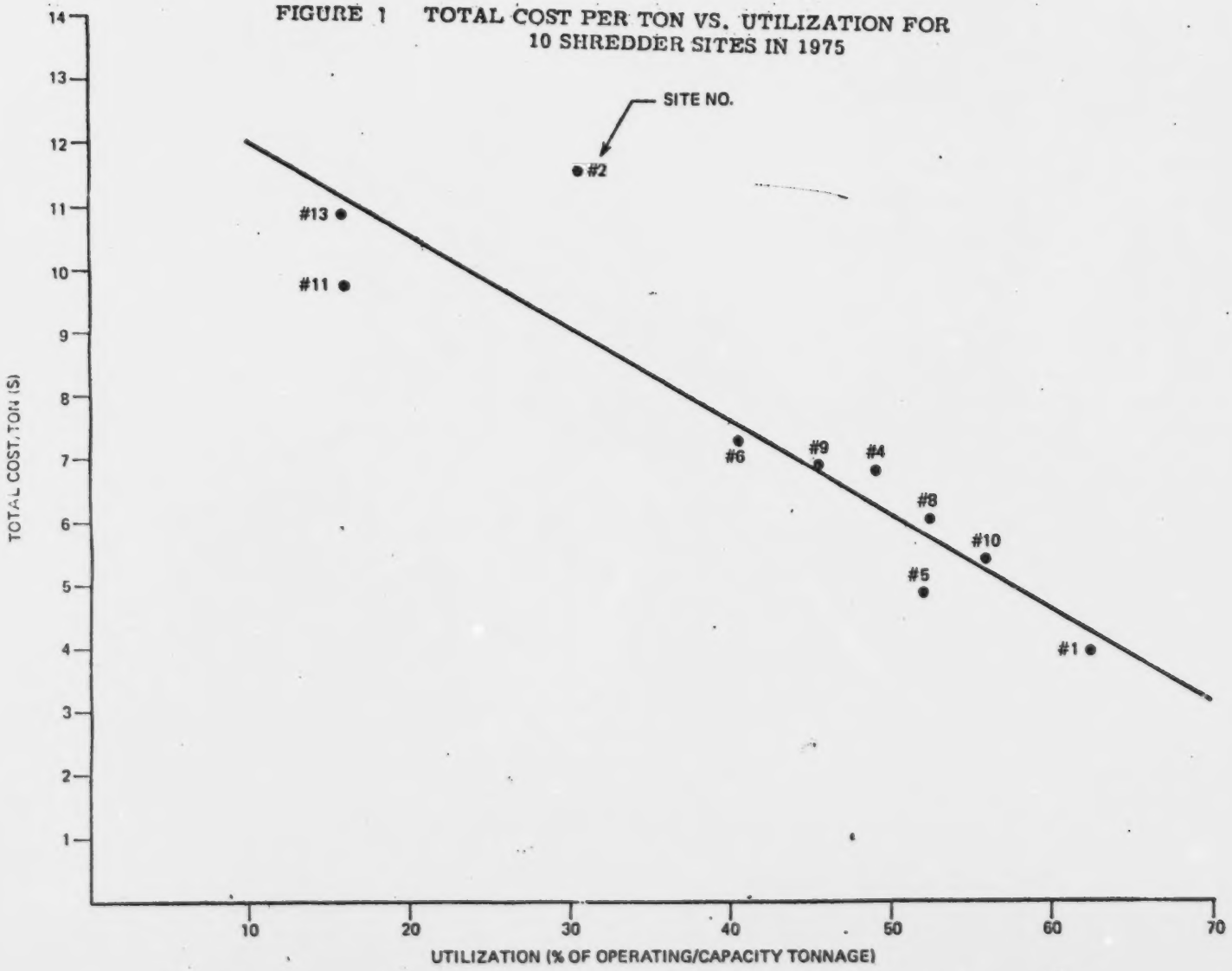

TABLE 17

DIRECT HAULING COSTS FOR 10 SHREDDER SITES IN 1975

Item	Site No. 1	2	3	4	5	6	7	8	9	10	Average
Characteristic											
Round Trip Distance To Landfill (Miles)	1/	24	28	35	6	1/	20	10	24	1/	
Tons/Year	205	61	185	271	29	44	46	58	81	81	
Direct Hauling Cost/Ton (Dollars)											
Operating Cost/Ton	.56	1.69	2.03	.47	.58	.81	1.74	1.38	1.10	1.06	1.14
Capital Cost/Ton	.23	.50	.50	.20	.37	.23	.32	.26	.57	.14	.33
Total Cost/Ton	.78	2.18	2.53	.67	.95	1.04	2.06	1.64	1.67	1.20	1.47

1/ Adjacent to the landfill

This section presents procedures for estimating the costs of shredder installations. The procedures should be used with current local cost data when available.

Capital Costs. Costs for the following categories should be developed in estimating capital costs.

(1) Land. The land requirements and the land costs for a shredder site are very dependent on a particular location. For estimating purposes, it can be assumed that a shredder installation requires a minimum of three to four acres of usable land. This land may be purchased, leased, or already owned. It is suggested that local land costs be obtained in determining the costs for this category.

Estimated land cost. . . . . ._____

(2) Site construction. Site construction costs vary con siderably due to differences in the required site development and in the facility design. Based on the survey, shredder sites with an operating level of 200 tons processed per day or less did not have costs of more than $600.000. Site construction costs for all shredders in the survey ranged from $178,000 to $3.3 million. In general, the sites with the lowest site construction costs had facilities which were modified from other operations.

Site construction cost estimates can be developed using an average of $275,000 per 100 tons of daily capacity.

The annualized site construction capital cost can be calculated by dividing the estimated total site construction costs less the salvage value by the depreciation period in years. The most common depreciation period for the site facilities and site developments of the sites visited was 20 years.

Estimated site construction cost . . . . . ._____

(3) Stationary Equipment. The total costs for stationary equipment associated with a shredding facility, such as the shredding machinery, conveyors, scales, and packers, vary with manufacturer, equipment capacity and features, and other factors. For estimating purposes, an equipment design to operating capacity factor of 2 might be used to develop equipment requirements. For example, if it is estimated that the shredder facility would have to process an average of 100 tons per 8 hours day, two shredders, each with a 25 ton per hour design capacity, might be selected. It is recommended that a minimum of two spearate shredders be included at a single conventional shredder site in order to minimize the effects of down time due to shredder repair and maintenance activities.

If shredder equipment costs are not readily available from manufacturers or other sources, they can be roughly estimated by multiplying the desired equipment design capacity in an 8 hour day by $1,400. This figure is based on the average of stationary equipment costs per ton of design capacity in an 8 hour day for the surveyed sites.

In calculating annualized capital costs for stationary equipment, the depreciation period can be assumed to be 15 years.

Estimated stationary equipment cost . . . . . .(total) _____
(annualized) _____

(4) Vehicular equipment. The vehicular equipment capital costs include the costs of all purchased vehicles that are utilized in the shredder facility itself, such as front end loaders and sweepers, and in the transportation of the shredded waste to a landfill or to another area for further processing. The number of transfer tractor/trailers required by a shredder operation depends on factors such as distance and time to the landfill or processing area, volume of solid waste, and the capacity of the trailers. Information on estimating the number and costs of tractor/trailers required is presented in the chapter on Transfer Systems. Costs of any other required vehicular equipment can be then added to determine the total vehicular equipment capital cost.

Alternatively, the vehicular equipment capital costs for shredder sites can be roughly estimated by multiplying the estimated average tons processed per day by $685. This is based on the average of the vehicle equipment cost to tons processed per day for the surveyed shredder sites.

The annualized capital cost for vehicular equipment is determined by the method described for site construction capital costs. Five years can be assumed as the depreciation period for vehicular equipment if other estimates are not available.

Estimated vehicular equipment cost. . . . . (total) _____
(annualized) _____

(5) Other equipment. The estimated costs for equipment not provided for in the previous equipment categories may be included in this category. Annualized capital costs can be calculated using a depreciation period in the typical range from 10 to 20 years.

Estimated other equipment cost. . . . . (total) _____
(annualized) _____

Operating Costs. Annual operating costs may be estimated by developing costs for the following categories.

(1) Labor. The salaries and wages and fringe benefits costs for all personnel involved in the shredder site operation are provided for in this category. The personnel typically included are supervisors, site employees, and vehicle operators. The salaries and wages cost can be calculated as follows:

Number of personnel by job category	x	Hourly wage for job category	x	Hours worked per day	x	Days of operation

The number of personnel required for the operation of a shredder site depends on a number of factors, such as number of shifts, time and distance to a landfill or processing area, and site design. Based on the survey, the number of shredder site employees required, such as equipment operators, laborers, and pit loader operators, can be approximated by using an average of 31 tons processed per day per site employee.

If the hourly wage rates are not known, average wage rates may be substituted, as determined by the survey. These are as follows: supervisor, $6.03 per hour; site employee, $4.75 per hour; and vehicle operator, $5.07 per hour.

The fringe benefits cost is calculated as follows:

Total salaries and wages cost x Fringe benefits rate

If the fringe benefits rate is not known, an average rate of 21 percent may be used.

Estimated salaries and wages cost . . . . . ._____
Estimated fringe benefits cost . . . . . ._____
Total, estimated labor cost . . . . . ._____

(2) Stationary equipment. The stationary equipment operating cost can be estimated by using an average cost per ton of $1.52.

Estimated stationary equipment cost . . . . . _____

(3) Vehicular equipment. An average cost of $.67 per ton for shredders located at a landfill or $.89 per ton for shredders not located at a landfill may be used for approximating the vehicular equipment operating costs, if most of the equipment is not rented.

Estimated vehicular equipment cost . . . . . _____

(4) Facilities and site maintenance. The costs for facilities and site maintenance may be estimated by using an average cost of $.17 per ton.

Estimated facilities and site maintenance cost . . . . . _____

(5) Utilities. The utilities cost category includes the costs for such items as electricity, water, gas, sewer, and telephone at the shredder facility. The electricity cost for shredder sites using electric-driven shredders can be estimated as $.60 to $.70 per ton. The cost of all other utilities can be calculated assuming $.13 per ton.

Estimated utilities cost . . . . . _____

(6) Administrative expenses. The administrative expense can be estimated using an average cost per ton of $.13.

Estimated administrative expenses . . . . . _____

(7) Other expenses. The other expenses cost category provides for those items not otherwise provided for in the other operating cost categories. A provision for these miscellaneous expenses can be made by using an average cost of $.21 per ton.

Estimated other expenses . . . . . _____

Tables 19 and 20 may be used in developing capital and operating cost estimates for shredder sites.

TABLE 18 SHREDDER CAPITAL COST WORKSHEET

1	2	3	4	5	6	7	8
Cost Category	Typical Items Included	Capital Cost	Depreciation Period	Annualized Cost	Cost/Ton	Survey Cost/Ton Average ($)	Survey Cost/Ton Range ($)
Land	Survey, legal, land cost					--	--
Site Construction	Planning and designing, site preparation, roadways, fencing, water lines, facilities					.60	.05 - 1.62
Stationary Equipment	Shredders, scales, conveyers, stationary packers					.61	.22 - 1.03
Vehicular Equipment	Transfer trucks and trailers, front end loaders, dump trucks, sweepers, cranes, dozers, pickup trucks					.46	.02 - .91
Other Equipment	Office equipment, maintenance equipment (welding equipment, compressors, etc.)					.02	0 - .14
Totals	--		--			1.69	.80 - 3.10

TABLE 19 SHREDDER OPERATING COST WORKSHEET

1	2	3	4	5	6
Cost Category	Typical Items Included	Annual Cost	Cost/Ton	Survey Cost/Ton Average ($)	Survey Cost/Ton Range ($)
Labor - Salaries and Wages	Regular, temporary, and overtime compensation to employees, e.g., supervisors, equipment operators, pit loader operators, laborers, transfer truck drivers, scalemen			1.77	1.15-3.55
Labor - Fringe Benefits	Workmen's Compensation, FICA, employee hospital, dental, life insurance, and retirement			.44	.15-1.13
Stationary Equipment	Repair and maintenance (in-house or contracted), parts and supplies, shop supplies, hand tools			1.52	.65-2.70
Vehicular Equipment	Repair and maintenance (in-house or contracted), parts and supplies, rental, fuel and oil			.82	.29-1.62
Facilities and Site Maintenance	Maintenance services (in-house or contracted), janitorial services, building materials, road materials, paint, plumbing supplies			.09	0- .34
Utilities	Electricity, water, gas, sewer, telephone			.66	.17-1.96
Administrative Expenses	Office supplies, uniforms and foul weather gear, travel, training, printing, postage, books, subscriptions, legal and accounting services, data processing			.13	0- .40
Other Expenses	Consulting engineering services, liability insurance, security services			.19	0- .77
Totals	--			5.61	2.85-9.50

BULKY ITEM SHREDDING

In a typical residential solid waste stream, about five percent of the waste will be bulky items such as furniture, stoves, water heaters, tires, etc. Because these items do not compact easily and are difficult to landfill, several cities have installed shredders for these items to facilitate landfilling.

The characteristics and costs of three bulky item shredders processing 31 to 63 tons per day are shown on Table 20. The sites had an average operating cost per ton of $12.14, or 72 percent of the total cost per ton, and an average annualized capital cost per ton of $4.55. All costs reflect the operation of the shredder facility itself and the transportation of the shredded waste to a landfill or to the next processing area.

Capital Costs

Capital costs for the three bulky item shredder operations are presented in Table 21. The sites had an average annualized capital cost per ton of $4.55, ranging from $4.01 to $5.62. Capital costs for the shredder sites were collected in five major categories: land, site construction, stationary equipment, vehicular equipment, and other equipment. Annualized capital costs were calculated for each cost category as described in the chapter on Transfer Systems, except for land, which was assumed to have infinite life. The annualized capital cost per ton to total costs per ton averaged 28 percent, ranging from 19 percent to 35 percent.

Land. Land costs were not available from the three bulky item shredder sites which were surveyed.

Site Construction. Site construction costs for the bulky item shredder sites averaged $1.79 per ton, ranging from $.23 to $3.18 per ton. Site construction costs were defined to include: planning and designing costs; site development costs, including site preparation, roadways, fencing, and water lines; and all construction costs for shredder facilities and associated buildings.

Stationary Equipment. The cost per ton of stationary equipment for bulky item shredder sites ranged from $.52 to $3.41 per ton and averaged $1.91. Stationary equipment costs included all fixed equipment purchased for a shredder site, such as shredding machinery, scales, conveyors, and stationary packers.

Vehicular Equipment. Vehicular equipment costs for bulky item shredder sites varied between $.12 and $.82 per ton, and averaged $.40. Vehicular equipment capital costs included the costs of all purchased vehicles associated with the shredder operation. Typically, these vehicles included transfer trucks, front end loaders, dump trucks, sweepers, cranes, dozers, and pickup trucks.

TABLE 20

CHARACTERISTICS OF BULKY ITEM SHREDDER SITES IN 1975

	Site No. 1	2	3	Average
Characteristics				
Average Tons/Day Processed	63	31	62	
Tons/Year Processed	16,457	8,060	11,759	
Days/Year of Operation	260	260	190	
Number of Shredders				
Shredder Type/Capacity (TPH)	Vert/60	Hor/25	Hor/40	
Site Acreage	2.5	--	10	
Storage Capacity (Tons)	--	150	0	
Resultant Particle Size (Inches)	3.6	3	14.4	
Roundtrip Distance to Landfill (Miles)	13	0	1	
Number of Shifts	1	1	1	
Number of Supervisors	2	5	1	
Number of Site Employees	4	5	2	
Number of Vehicle Operators	2	0	1	
Cost				
Total Operating Costs:	281.7	83.1	105.6	
Total/Year (1,000 dollars)	17.12	10.32	8.98	12.14
Cost/Ton (dollars)	81	65	69	72
% of Total Cost				
Total Annualized Capitol Costs:	65.9	45.3	47.4	--
Total/Year (1,000 dollars)	4.01	5.62	4.03	4.55
Cost/Ton (dollars)	19	35	31	28
% of Total Cost				
Total Cost:				
Total/Year (1,000 dollars)	347.6	128.5	153.0	--
Cost/Ton (dollars)	21.12	15.94	13.01	16.69

TABLE 21

CAPITAL COSTS OF 3 BULKY ITEM
SHREDDER SITES IN 1975

Cost Item	Site No. 1	2	3	Average
Land				
Total Cost (1,000 dollars)	-	-	-	
Site Construction				
Total Cost (1,000 dollars)	1,048	238	27	
Annualized Cost (1,000 dollars)	52.4	15.9	2.7	
Cost/Ton (dollars)	3.18	1.97	.23	1.79
Stationary Equipment				
Total Cost (1,000 dollars)	128	412	211	
Annualized Cost (1,000 dollars)	8.5	27.5	21.1	
Cost/Ton (dollars)	.52	3.41	1.79	1.91
Vehicular Equipment				
Total Cost (1,000 dollars)	12	10	48	
Annualized Cost (1,000 dollars)	2.0	2.0	9.6	
Cost/Ton (dollars)	.12	.25	.82	.40
Other Equipment				
Total Cost (1,000 dollars)	15	0	140	
Annualized Cost (1,000 dollars)	3.0	0	14.0	
Cost/Ton (dollars)	.18	0	1.19	.46
Totals				
Total Cost (1,000 dollars)	1,203	660	426	
Annualized Cost (1,000 dollars)	65.9	45.3	47.4	
Cost/Ton (dollars)	4.01	5.62	4.03	4.55

Other Equipment. Two bulky item shredder sites had other equipment costs of $.18 and $1.19 per ton, with an average for the three sites of $.46. Other equipment capital costs included the costs of all other purchased equipment that is capitalized and not provided for within the site construction, stationary equipment, or vehicular equipment cost categories. Items in the other equipment category included office equipment and maintenance equipment, such as welding equipment and compressors.

Operating Costs

Total operating costs per ton averaged $12.14 for bulky item shredder sites. The range in operating costs per ton was from $8.98 to $17.12. Operating costs averaged 72 percent of total annual costs, ranging from 65 percent to 81 percent. Annual operating costs, excluding annualized capital costs, are presented in Table 22 The operating costs are grouped into seven major categories: labor, stationary equipment, vehicular equipment, facilities and site maintenance, utilities, administrative expenses, and other expenses. Operating cost per ton figures are displayed in Table 23.

Labor. Total labor cost per ton, including salaries and wages and fringe benefits, varied from $2.46 to $6.06, averaging $4.42 per ton. Labor costs amounted to an average of 36 percent of total operating costs, ranging from 27 percent to 46 percent.

The labor cost category is composed of both salaries and wages and fringe benefits costs. The salaries and wages cost provides for regular, temporary, and overtime compensation paid to personnel directly involved with the plant operation. Employees typically included were supervisors, equipment operators, pit loader operators, laborers, transfer truck drivers, and scalemen. Salaries and wages averaged $3.85 per ton, ranging from $2.17 to $5.44 per ton.

Fringe benefits provide for those costs incurred for workmen's compensation; FICA; employee hospital, dental, and life insurance; retirement; and other benefits not paid for by the employee. Fringe benefits averaged $.57 per ton, ranging from $.28 to $.80 per ton.

Stationary Equipment. The cost per ton averaged $3.38, with a range from $2.00 to $5.23. Stationary equipment operating costs averaged 27 percent of total operating costs, ranging from 22 percent to 31 percent.

The stationary equipment cost category is composed of those costs associated with the repair and maintenance, including parts and supplies, of all fixed equipment at the shredder facility, such as the shredders and conveyors. The repair and maintenance cost element represents the labor costs for work performed by shredder facility personnel, such as maintenance personnel and welders, or fees paid to private firms or to other organizational units. Parts and supplies include replacement and

TABLE 22

OPERATING COSTS OF 3 BULKY ITEM SHREDDER SITES IN 1975
(1,000 DOLLARS)

Cost Item	Site No. 1	2	3
Labor			
Salaries and Wages	89.5	31.8	25.5
Fringe Benefits	10.1	6.5	3.3
Total, Labor	99.7	38.3	28.9
Stationary Equipment			
Repair and Maintenance	60.1	11.7	21.8
Parts and Supplies	25.9	11.8	1.7
Other Equipment Expense	0	0	0
Total, Stationary Equipment	86.0	23.6	23.5
Vehicular Equipment			
Repari and Maintenance	0	.3	7.8
Parts and SUpplies	0	.2	0
Rental	52.0	0	17.5
Fuel and Oil	0	1.0	.4
Total, Vehicular Equipment	52.0	1.5	25.7
Facilities and Site Maintenance	0	5.5	.01
Utilities			
Electricity	15.6	6.7	5.6
Other	8.4	1.7	.2
Total, Utilities	24.0	8.4	5.8
Administrative Expense	20.0	3.0	15.9
Total	281.7	83.1	105.6

TABLE 23

OPERATING COSTS PER TON OF 3 BULKY ITEM SHREDDER SITES IN 1975
(DOLLARS)

Cost Item	Site No. 1	2	3	Average
Labor				
Salaries and Wages	5.44	3.95	2.17	3.85
Fringe Benefits	.62	.80	.28	.57
Total, Labor	6.06	4.75	2.46	4.42
Stationary Equipment				
Repair and Maintenance	3.65	1.47	1.86	
Parts and Supplies	1.58	1.46	.14	
Other Equipment Expense	0	0	0	
Total, Stationary Expense	5.23	2.92	2.00	3.38
Vehicular Equipment				
Repair and Maintenance	0	.04	.66	
Parts and Supplies	0	.02	0	
Rental	3.16	0	1.49	
Fuel and Oil	0	.12	.03	
Total, Vehicular Equipment	3.16	.18	2.19	1.84
Facilities and Site Maintenance	0	.68	.001	.34
Utilities				
Electricity	.95	.84	.48	
Other	.51	.03	.01	
Total, Utilities	1.46	1.04	.49	1.00
Administrative Expense	1.22	.38	1.35	.98
Other Expenses	0	.36	.50	.29
Total, Operating Cost/Ton	17.12	10.32	8.98	12.14

maintenance items associated with the stationary equipment, such as hammers and lubricants. The stationary equipment category also includes other equipment expenses incurred for non-capitalized equipment. The other equipment expense costs element provides for miscellaneous itmes such as shop supplies, welding supplies and hand tools.

Vehicular Equipment. Vehicular equipment operating cost per ton averaged $1.84 and had a range of $.18 to $3.16. The average percentage of vehicular equipment operating costs to total operating costs was 15 percent, ranging from 2 percent to 24 percent.

Vehicular equipment costs include those expenses incurred for the repair and maintenance, parts and supplies, rental, and fuel and oil for vehicles. Repair and maintenance costs generally represent labor charges by other organizational units or by private contractors, but also include labor costs for major vehicular repairs and maintenance activities when done on a full-time or part-time basis by personnel assigned to the shredder facility. Parts and supplies include all replacement and maintenance items utilized for the vehicles, such as batteries, tires, and lubricants. Rental provides for all expenses incurred when vehicluar equipment is rented or leased from another organizational unit or from a private firm. Fuel and oil includes those costs for gasoline, diesel fuel, and motor oil used in the operation of the vehicular equipment.

Facilites and Site Maintenance. The cost per ton averaged $.34 and ranged from zero to $.68 per ton. Costs included in the facilities and site maintenance category are the labor and materials expensesd incurred in maintaining the structures and grounds at the shredder site. Typical costs are in-house or contracted maintenance and janitorial services, building materials, road materials, paint, and plumbing supplies.

Utilities. The total utilities cost averaged $1.00 per ton, varying between $.49 and $1.46 per ton. The utilities cost category privides for the electricity, water, gas, sewer, and telephone expenses incurred in the operation of the shredder facility.

Administrative Expenses. Administrative expenses averaged $.98 per ton, varying from $.38 to $1.35 per ton. The administrative expense category provides for general operating expenses directly incurred by the shredder facility. Included are costs for office supplies, uniforms and foul weather gear, travel, training, printing, postage, books and subscriptions, legal and accounting services, and data processing.

Other Expenses. The cost per ton for other expenses averaged $.29 per ton and ranged from zero to $.50 per ton. Costs included in this category are for those items not provided for in the previous cost categories. For example, the costs of consulting engineering services, liability insurance, and security services are considered to be in this category.

Variations in Costs

Primary sources of variation in the capital and operating costs of the three shredder sites were: (1) tons processed per day; (2) depreciation schedules; (3) wage and fringe benefits rates; (4) distance to landfill or processing area.

Tons Processed Per Day. The three bulky item shredder sites, ranging from 31 to 63 tons per day, had an average total cost per ton of $16.69. The total cost per ton figures for the bulky item shredders, each of which handled fewer tons per day than any of the regular shredders described in the previous chapter, were higher than for any of the regular shredders.

Depreciation Schedules. The depreciation method and period utilized for the facilities, stationary equipment, and vehicular equipment of a shredder site affects the total annualized capital costs and the capital costs per ton. Depreciation for all shredder sites was calculated on a straight-line basis, using the depreciation period being utilized by the particular site. Table 24 shows the depreciation periods of items within the site construction, stationary equipment, and vehicular equipment capital cost categories utilized by the various sites.

Wage and Fringe Benefits Rates. The labor cost portion of operating costs is directly affected by the local wage and fringe benefits rates. The average hourly wage rates for supervisor, site worker, and vehicle operator personnel for each of the shredder sites are presented in Table 25. Table 28 also gives the fringe benefits rates by site. The supervisor average hourly rate averaged $7.09, ranging between $5.77 and $8.19. Site employees averaged $6.03 per hour and vehicle operators averaged $6.60 per hour, varying from $3.57 to $7.64 and $6.15 to $7.05, respectively. The percentage of fringe benefits to the total salaries and wages ranged from 11 percent to 20 percent, with an average of 15 percent.

Distance to Landfill or Processing Area. The distance between the shredder site and a landfill or an area where other processing occurs affects the total operating and capital costs per ton. The round-trip distance for the bulky item shredder sites varied from zero to 13 miles. The direct hauling costs per ton and the round-trip distance for the bulky item shredder sites are presented in Table 26. The total direct hauling costs averaged $3.65 per ton, ranging from $2.65 to $4.65 per ton. Site No. 2 had no direct hauling costs because the shredded waste was fed directly into an incinerator.

Cost Estimating

This section presents procedures for estimating the costs of bulky item shredder installations. The procedures should be used with current local cost data when available.

TABLE 24

DEPRECIATION PERIODS FOR 3 BULKY ITEM SHREDDER SITES
(YEARS)

Site No.	Site Construction	Stationary Equipment	Vehicular Equipment
1	30	15	5
2	15	15	5
3	10	10	5
Range	10-30	10-15	5

TABLE 25

WAGE RATES AND FRINGE BENEFITS RATES
FOR 3 BULKY ITEM SHREDDER SITES IN 1975

Site No.	Supervisor Avg. Hourly Wage	Site Employee Avg. Hourly Wage	Vehicle Operator Avg. Hourly Wage	Fringe Benefits Rate
1	8.19	7.64	7.05	11
2	5.77	3.57	--	20
3	7.31	6.87	6.15	13
Average	7.09	6.03	6.60	15
Range	5.77-8.19	3.57-7.64	6.15-7.05	11-20

TABLE 26

DIRECT HAULING COSTS FOR 3 BULKY ITEM
SHREDDER SITES IN 1975

Item	Site no. 1	Site no. 2	Site no. 3	Average
Characteristic				
Round Trip Distance to Landfill (Miles)	13	0	1	
Tons/Year	16,457	8,060	11,759	
Direct Hauling Cost/Ton (dollars)				
Operating Cost/Ton	4.65	--	2.65	3.65
Capital Cost/Ton	0	--	0	0
Total Cost/Ton	4.65	--	2.65	3.65

Capital Costs. Costs for the following categories should be developed in estimating capital costs.

(1) Land. The land requirements and the land costs for a shredder site are very dependent on a particular location. For estimating purposes, it can be assumed that a shredder installation requires a minimum of three to four acres of usable land. This land may be purchased, leased, or already owned. It is suggested that local land costs be obtained in determining the costs for this category.

Estimated land cost. . . . . _____

(2) Site construction. Site construction costs vary considerably due to differences in the required site development and in the facility design. Bulky item shredder site construction costs can be estimated using an average of $8,400 per ton of daily capacity.

The annualized site construction capital cost can be calculated by dividing the estimated total site construction costs less the salvage value by the depreciation period in years. A depreciation period of 20 years may be used for items in the site construction category.

Estimated site construction cost. . . . . (total)_____
(annualized)_____

(3) Stationary equipment. The total costs for stationary equipment associated with a shredding facility, such as the shredding machinery, conveyors, scales, and packers, vary with manufacturer, equipment capacity and features, and other factors.

If shredder equipment costs are not readily available from manufacturers or other sources, they can be roughly estimated by multiplying the desired equipment design capacity in an eight hour day by $1,000 for bulky item shredders. This figure is based on the average of the stationary equipment costs per ton of design capacity in an eight hour day for the sites in the survey.

Operating Costs. Annual operating costs may be developed by estimating costs for the following categories.

(1) Labor. The salaries and wages and fringe benefits costs for all personnel involved in the shredder site operation are provided for in this category. The personnel typically included

are supervisors, site employees, and vehicle operators. The salaries and wages cost can be calculated as follows:

Number of personnel by job category	x	Hourly wage for job category	x	Hours worked per day	x	Days of operation

The number of personnel required for the operation of a shredder site depends on a number of factors, such as number of shifts, time and distance to a landfill or processing area, and site design. Based on the survey, the number of bulky item shredder site employees required, such as equipment operators, laborers, and pit loader operators, can be approximated by using an average of 14 tons processed per day per site employee.

If the hourly wage rates are not known, average hourly wages rates may be substituted as follows: supervisor, $7.09; site employee, $6.03; and vehicle operator, $6.60.

The fringe benefits cost can be calcualted by multiplying the total salaries and wages cost by the fringe benefits rate. If the local fringe benefits rate is not known, an average rate of 15 percent may be utilized.

Estimated salaries and wages cost. . . . . ._____
Estimated fringe benefits cost . . . . . ._____
Total, estimated labor cost . . . . . ._____

(2) Stationary equipment. The stationary equipment operating cost can be estimated by using an average cost per ton of $3.38.

Estimated stationary equipment cost. . . . . ._____

(3) Vehicular equipment. An average cost of $1.84 per ton may be used for approximating the total annual vehicular equipment operating costs if most of the equipment is not rented.

Estimated vehicular equipment cost . . . . . ._____

(4) Facilities and site maintenance. The costs for facilities and site maintenance may be estimated by using an average cost of $.34 per ton.

Estimated facilities and site maintenance cost . . . . . ._____

(5) Utilities. The utilities cost category includes the costs for such items as electricity, water, gas, sewer, and telephone at the shredder facility. The cost of utilities can be calculated assuming an average of $1.00 per ton.

Estimated utilities cost. . . . . ._____

(6) Administrative expense. The administrative expense can be estimated using an average cost per ton of $.98.

Estimated administrative expense. . . . . _____

(7) Other expenses. The other expenses cost category provides for those items not otherwise provided for in the other operating cost categories. A provision for these miscellaneous expenses can be made by using an average cost of $.29 per ton.

Estimated other expenses. . . . . _____

Tables 27 and 28 may be used in developing capital and operating cost estimates for bulky item shredder sites.

TABLE 27 BULKY ITEM SHREDDER CAPITAL COST WORKSHEET

1	2	3	4	5	6	7	8
Cost Category	Typical Items Included	Capital Cost	Depreciation Period	Annualized Cost	Cost/Ton	Survey Cost/Ton Average ($)	Survey Cost/Ton Range ($)
Land	Survey, legal, land cost					--	--
Site Construction	Planning and designing, site preparation, roadways fencing, water lines, facilities					1.79	.23 - 3.18
Stationary Equipment	Shredders, scales, conveyers, stationary packers					1.91	.52 - 3.41
Vehicular Equipment	Transfer trucks and trailers, front end loaders, dump trucks, sweepers, cranes, dozers, pickup trucks					.40	.12 - .82
Other Equipment	Office equipment, maintenance equipment (welding equipment, compressors, etc.)					.46	0 - 1.19
Totals	--		--			4.55	4.01 - 5.62

TABLE 28 BULKY ITEM SHREDDER OPERATING COST WORKSHEET

1	2	3	4	5	6
Cost Category	Typical Items Included	Annual Cost	Cost/Ton	Survey Cost/Ton Average ($)	Survey Cost/Ton Range ($)
Labor - Salaries and Wages	Regular, temporary, and overtime compensation to employees, e.g., supervisors, equipment operators, pit loader operators, laborers, transfer truck drivers, scalemen			3.85	2.17 - 5.44
Labor - Fringe Benefits	Workmen's Compensation, FICA, employee hospital, dental, life insurance, and retirement			.57	.28 - .80
Stationary Equipment	Repair and maintenance (in-house or contracted), parts and supplies, shop supplies, hand tools			3.38	2.00 - 5.23
Vehicular Equipment	Repair and maintenance (in-house or contracted), parts and supplies, rental, fuel and oil			1.84	.18 - 3.16
Facilities and Site Maintenance	Maintenance services (in-house or contracted), janitorial services, building materials, road materials, paint, plumbing supplies			.34	0 - .68
Utilities	Electricity, water, gas, sewer, telephone			1.00	.49 - 1.45
Administrative Expenses	Office supplies, uniforms and foul weather gear, travel, training, printing, postage, books, subscriptions, legal and accounting services, data processing			.98	.38 - 1.35
Other Expenses	Consulting engineering services, liability insurance, security services			.29	0 - .30
Totals	--			12.14	8.98 - 17.12

SANITARY LANDFILLING

Sanitary landfilling is a disposal method whereby solid wastes are spread in thin layers over a prescribed area of land, compacted, and covered each day with a required amount of cover material. Generally, the depth of cover material is established by state or local regulations. Regardless of whether the solid wastes are processed or not, the solid waste or waste residue generally must be landfilled.

A variety of landfilling methods may be followed, depending upon the type and volume of the solid wastes and the physical condition of the land. Both operating and capital costs vary with the landfilling method and with the waste composition and volume. For example, if primarily residential and commercial solid wastes are landfilled, a high compaction ratio is possible. This reduces the volume and extends the life of the landfill. If bulky wastes, such as construction debris, trees, and stumps, form a large portion of the refuse, a lesser compaction ratio is attained.

The advantages of sanitary landfilling are: (1) it is generally the least expensive method of solid waste disposal; and (2) capital investment is low. The disadvantages are that land meeting all environmental requirements may not be available and that cover material may be expensive to obtain.

The characteristics of the 17 sanitary landfill sites which were surveyed are shown in Table 29. The landfills differ in daily tons received, ranging from 99 to 1,014 tons per day. The number of operating days per year, varied from 260 to 360 days. The landfills differed significantly in number of employees needed to place and cover 100 tons of solid waste and in the type and amount of equipment used. The landfills are similar in that all are publicly owned and operated.

The annual operating and annualized capital costs of the 17 landfill sites are summarized in Table 30. Operating costs averaged $2.38 per ton, or 78 percent of total annual costs. Annualized capital costs averaged $.68 per ton, or 22 percent of total annual costs, resulting in an average total cost of $3.06 per ton.

Capital Costs

The capital costs reported by each of the 17 landfill sites are presented in Table 30. The average annualized capital cost per ton was $.68, with a range of $.07 to $1.55 per ton. Annualized capital costs averaged 22 percent of total annual costs, ranging from 4 percent to 46

TABLE 29

CHARACTERISTICS OF 17 LANDFILL SITES IN 1975

Characteristic	Site No. 1	2	3	4	5	6	7	8	9
Average Tons/Day	107	1,014	548	264	99	205	172	753	173
Tons/Year	33,600	263,700	170,000	68,640	30,000	64,400	49,250	226,000	45,000
Days/Year of Operation	313	260	310	260	302	304	286	300	260
Acreage	60	81	200	60	44.7	180	35	215	14
Compaction Density (lbs./cu. yd.)	800	900	1,000	--	800	800	--	1,000	1,100
Number of Supervisors	1	3	.5	1	1	1	1	1	.5
Number of Employees	2	21	5	2	4	5	4	5	2
Total Operating Costs:									
Total/Year (1,000 dollars)	60.0	1,008	262	72	162	180	195	295	77
Cost/Ton (dollars)	1.77	3.82	1.5	1.04	5.41	2.89	3.96	1.31	1.72
% of Total Cost	54	91	96	69	80	77	88	95	66
Total Annualized Capital Costs:									
Total/Year (1,000 dollars)	51	98	12	32	39	53	26	15	41
Cost/Ton (dollars)	1.53	.37	.07	.46	1.31	.85	.52	.07	.92
% of Total Cost	46	9	4	31	20	23	12	5	34
Total Cost:									
Total/Year (1,000 dollars)	110.9	1,106.6	273.5	103.2	201.7	233.1	220.8	310.3	118
Cost/Ton (dollars)	3.3	4.20	1.61	1.5	6.72	3.74	4.48	1.37	2.62

TABLE 29 (a)

CHARACTERISTICS OF 17 LANDFILL SITES IN 1975

Characteristic	Site No. 10	11	12	13	14	15	16	17	Average
Average Tons/Day	275	233	577	162	555	360	530	255	
Tons/Year	78,200	65,200	165,000	58,200	166,400	93,600	165,400	78,900	
Days/Year of Operation	285	280	286	360	300	260	312	309	
Acreage	24	295	83	1,500	137	227	6[illegible]	160	
Compaction Density (lbs./cu. yd.)	990	--	1,100	--	1,000	--	--	--	
Number of Supervisors	1	1	1	.3	1	1	1	1	
Number of Employees	8	9	21	2	7	3	13	4	
Total Operating Costs:									
Total/Year (1,000 dollars)	224	253	357	71	167	92	429	189	
Cost/Ton (dollars)	2.86	3.88	2.16	1.22	1.00	.98	2.60	2.40	2.38
% of Total Cost	65	87	64	94	65	72	75	90	78
Total Annualized Capital Costs:									
Total/Year (1,000 dollars)	121	38	197	11	90	35	141	21	
Cost/Ton (dollars)	1.55	.58	1.20	.19	.54	.38	.85	.27	.68
% of Total Cost	35	13	36	6	35	28	25	10	22
Total Cost:									
Total/Year (1,000 dollars)	345	291	554	82	257	127	570	210	
Cost/Ton (dollars)	4.41	4.46	3.36	1.41	1.54	1.36	3.45	2.67	3.06

TABLE 30

CAPITAL COSTS FOR 17 LANDFILLS IN 1975

Cost Item	Site No. 1	2	3	4	5	6	7	8
Land								
Total Cost (1,000 dollars)	0	85	190	60	94	165	40	108
Annualized Cost (1,000 dollars)	6.0(1)	5.3	9.5	4.6	10.4	1.5	5.7	6.7
Cost/Ton (dollars)	.18	.02	.06	.07	.35	.02	.12	.03
Site Construction								
Total Cost (1,000 dollars)	162	200	33	0	6	0	40	2
Annualized Cost (1,000 dollars)	8.1	12.5	1.6	0	.9	0	5.8	.1
Cost/Ton (dollars)	.24	.05	.01	0	.03	0	.12	.001
Stationary Equipment								
Total Cost (1,000 dollars)	2	18	10	0	12	25	10	10
Annualized Cost (1,000 dollars)	.5	1.8	.7	0	1.2	2.5	1.1	1.1
Cost/Ton (dollars)	.01	.01	.004	0	.04	.04	.02	.004
Vehicular Equipment								
Total Cost (1,000 dollars)	179	683	0	135	134	177	104	35
Annualized Cost (1,000 dollars)	36.7	78.7	0	27.0	26.8	35.3	13.0	7.0
Cost/Ton (dollars)	1.09	.30	0	.39	.89	.57	.26	.03
Total								
Total Cost (1,000 dollars)	344	987	233	195	245.4	367	194	155
Annualized Cost (1,000 dollars)	51.3	98.4	11.8	31.6	39.3	52.9	25.6	14.9
Cost/Ton (dollars)	1.53	.37	.07	.46	1.31	.85	.52	.07

(1) Land is leased.

TABLE 30 (a)

Cost Item	Site No.									
	9	10	11	12	13	14	15	16	17	Average
Land										
Total Cost (1,000 dollars)	56	50	295	83	245	283	0	680	65	
Annualized Cost (1,000 dollars)	8.0	10.0	14.8	4.2	7	28.3	6.0[1]	70.0	5.0	
Cost/Ton (dollars)	.18	.13	.23	.02	.11	.17	.06	.42	.06	.13
Site Construction										
Total Cost (1,000 dollars)	171	344	59	5	0	157	111	10	90	
Annualized Cost (1,000 dollars)	24.4	68.8	3.9	.2	0	15.7	11.1	.6	6.9	
Cost/Ton (dollars)	.54	.88	.06	.002	0	.09	.12	.004	.09	.13
Stationary Equipment										
Total Cost (1,000 dollars)	0	7	9	6	0	0	37	0	16	
Annualized Cost (1,000 dollars)	0	1.4	.9	2.1	0	0	3.3	0	1.2	
Cost/Ton (dollars	0	.02	.01	.01	0	0	.04	0	.02	.01
Vehicular Equipment										
Total Cost (1,000 dollars)	37	398	138	573	94	225	87	458	55	
Annualized Cost (1,000 dollars)	8.1	41.0	18.3	191.0	4.4	45.1	14.8	70.6	7.8	
Cost/Ton (dollars)	.18	.52	.28	1.16	.08	.27	.16	.43	.10	.33
Total										
Total Cost (1,000 dollars)	264	799	501	667	339	665	231	468	226	
Annualized Cost (1,000 dollars)	40.5	121.2	37.9	197.5	11.1	90.3	35.2	141.2	21.0	
Cost/Ton (dollars)	.90	1.55	.58	1.20	.19	.54	.38	.85	.27	.63

percent. Capital costs associated with a sanitary landfill include the purchasing and preparing of the land, constructing the necessary buildings, fences, and roads, and purchasing of stationary and vehicular equipment required for the operation.

Land. Annualized land capital costs averaged $.13 per ton, with a range of $.02 to $.42 per ton. Land costs were annualized using the estimated expected life of the landfill, based on the anticipated capacity. The price per acre averaged $1,896, varying from $163 to $10,000 per acre. Fifteen of the seventeen survey sites had purchased land for use as a sanitary landfill. Two of the sites leased the required land for approximately $6,000 per year. Most sites in the survey deposited from 15,000 to 35,000 tons per acre.

Site Construction. Annualized site construction capital costs averaged $.13 per ton, and ranged between zero and $.88 per ton. Site construction costs include: design costs, site preparation costs (surveys, demolition, grading, and excavating), and construction costs for roads, fences, and utilities. Three of the sites did not report any site construction costs. Three of the sites incurred significant costs for roads.

Stationary Equipment. Annualized capital costs for stationary equipment averaged $.01 per ton, varying between zero and $.04 per ton. Stationare equipment includes scales, air compressors, and maintenance equipment, such as welding and vehicle repair equipment. Five of the survey sites reported no capital investment for stationary equipment. In most cases, these sites weighed the solid waste at a transfer station or shredder facility.

Vehicular Equipment. The annualized capital costs per ton for vehicular equipment averaged $.39, and ranged from zero to $1.16 per ton. Vehicular equipment items purchased by the landfill sites included dozers, loaders, graders, compactors, and scrapers. The vehicular equipment category was the largest capital cost category for the majority of the landfill sites. One site leased all vehicular equipment.

Operating Costs

The operating costs of the 17 landfills averaged $2.40 per ton, or 78 percent of total annual costs. Individual sites varied between an operating cost of $.98 and $5.41 per ton. Operating costs to total costs ranged from 54 percent to 96 percent.

The annualized operating costs are displayed in Table 31 and operating costs per ton are shown in Table 32. The operating data are presented in eight categories: labor, stationary equipment, vehicular equipment, facilities and site maintenance, utilities, cover material, administrative expense, and other expenses.

TABLE 31

ANNUAL OPERATING COSTS FOR 17 LANDFILL SITES IN 1975
(DOLLARS)

Cost Item	Site No. 1	2	3	4	5	6	7	8
Labor								
Salaries and Wages	33.4	434.6	103.4	27.1	55.5	41.5	88.7	82.1
Fringe Benefits	2.3	65.5	14.5	3.3	7.1	5.9	20.2	11.2
Total, Labor	35.7	500.2	117.9	30.4	62.6	47.4	108.8	93.3
Stationary Equipment								
Repair and Maintenance	.03	2.7	0	0	6.3	0	3.1	2.0
Parts and Supplies	.02	4.5	0	0	0	0	0	0
Other Equipment Expense	1.5	.3	.7	0	3.1	0	.6	0
Total, Stationary Equipment	1.5	7.6	.7	0	9.3	0	3.7	2.0
Vehicular Equipment								
Repair and Maintenance	2.9	57.1	21.0	10.7	37.4	17.9	22.8	0
Parts and Supplies	10.7	82.6	(1)	16.0	(1)	(1)	37.2	0
Rental	.2	9.7	120.0	3.5	34.0	4.2	.4	102.0(2)
Fuel and Oil	1.5	46.8	(5)	4.6	7.4	8.0	10.1	28.0
Total, Vehicular Equipment	15.3	196.2	141.0	34.8	78.8	30.1	70.6	130.0
Facilities and Site Maintenance	.2	53.7	.3	2.3	9.6	95.1	1.7	8.5
Utilities	.4	3.8	.7	.1	.6	1.2	.7	.4
Cover Material	0	212.9	0	0	0	0	3.3	0
Administrative Expense	6.4	22.8	.1	.5	1.5	5.4	5.3	7.3
Other Expenses	.3	11.2	1.0	3.5	0	1.1	1.1	54.0
Total	59.6	1,008.3	261.7	71.6	162.4	180.3	195.2	295.5

(1) Included in Repair and Maintenance
(2) Includes Repair and Maintenance and Parts and Supplies
(3) Included in Repair and Maintenance and Rental
(4) Includes a portion of Repair and Maintenance and Parts and Supplies
(5) Included in Rental

TABLE 31 (a)

Cost Item	Site No. 9	10	11	12	13	14	15	16	17
Labor									
Salaries and Wages	43.6	125.4	122.6	131.0	25.2	75.6	36.9	212.0	60.2
Fringe Benefits	14.4	41.4	31.7	24.9	4.6	18.9	5.3	51.1	18.1
Total, Labor	58.0	166.8	154.2	155.9	29.9	94.5	42.2	263.1	78.3
Stationary Equipment									
Repair and Maintenance	0	0	0	4.7	0	0	2.2	0	.2
Parts and Supplies	0	0	0	10.7	0	.8	(1)	0	0
Other Equipment Expense	0	0	0	1.2	.1	0	0	0	0
Total, Stationary Equipment	0	0	0	16.6	.1	.8	2.2	0	.2
Vehicular Equipment									
Repair and Maintenance	3.7	15.6	80.1	31.8	17.6	12.4	19.3	107.2	20.8
Parts and Supplies	2.5	10.4	(1)	60.8	(1)	18.5	(1)	25.5	(3)
Rental	0	0	0	0	21.0	1.2	0	7.5	67.2 (4)
Fuel and Oil	6.4	26.7	(1)	24.7	1.1	20.0	20.0	20.1	14.3
Total, Vehicular Equipment	12.6	52.7	80.1	117.3	39.7	52.1	39.3	160.3	102.4
Facilities and Site Maintenance	6.7	4.3	0	30.0	0	13.7	.5	2.9	0
Utilities	0	.1	1.0	1.3	.2	.4	.6	1.8	1.5
Cover Material	0	0	0	0	0	0	0	0	0
Administrative Expense	0	0	8.1	8.5	1.4	5.2	2.1	2.1	7.1
Other Expenses	0	0	10.6	27.3	.1	.4	5.6	0	0
Total	77.3	223.9	253.0	356.9	71.3	167.1	91.9	429.2	189.4

Labor. The total labor cost per ton averaged $1.20, with a range from $.41 to $2.36 per ton. On a percentage basis labor costs to total operating costs averaged 50 percent, ranging from 26 percent to 75 percent.

Labor costs include salaries and wages paid to employees, and the associated fringe benefits costs. Salaries and wages include regular, temporary, and overtime pay to those persons employed at the landfill or directly associated with its operation. Such persons may include supervisors, scale operators, and equipment operators. Salaries and wages costs ranged from $.36 to $1.88 per ton, averaging $.99 per ton.

Fringe benefits costs include expenses for social security, medical and dental insurance, workmen's compensation, and unemployment compensation. Fringe benefits averaged $.21 per ton, with a range of $.05 to $.53 per ton.

Stationary Equipment. Stationary equipment operation costs per ton averaged $.04, ranging from zero to $.31 per ton. The percentage of stationary equipment operating costs to total operating costs ranged from zero percent to 6 percent, averaging 1 percent. Only 11 of the 17 sites surveyed reported operating costs for stationary equipment.

Operating expenses associated with stationary equipment primarily involve the costs for repair to scales, maintenance labor, replacement parts, and operating supplies, such as lubricants. The purchase of non-capitalized equipment such as shop equipment, hand tools, and communication devices can also be included in this cost category. Examples of stationary equipment items utilized at a landfill site are scales, air compressors, two-way radios, and "credit card" readers.

Vehicular Equipment. The vehicular equipment operating costs averaged $.84 per ton, with a range of $.21 to 2.63. The percentage of vehicular equipment operating costs to total operating costs ranged from 16 percent to 56 percent, with an average of 36 percent.

Costs associated with the operation and maintenance of vehicular equipment at a landfill include those for maintenance labor and parts and supplies. This category also included costs for equipment that was rented or leased from another agency or from a private concern. In addition, fuel and oil costs are provided for in this category.

Facilities and Site Maintenance. An average cost of $.16 per ton was computed for facilities and site maintenance costs. These costs ranged between zero and $1.52 per ton. The percentage of these costs to total operating costs had a range of zero percent to 53 percent, with an average of 6 percent. This category provides for the costs of such maintenance activities as road repair, painting, rodent control, and landscaping.

TABLE 32

OPERATING COSTS PER TON FOR 17 LANDFILL SITES IN 1975
(DOLLARS)

Cost Item	Site No. 1	2	3	4	5	6	7	8	9
Labor									
Salaries and Wages	.99	1.65	.61	.39	1.85	.66	1.80	.36	.97
Fringe Benefits	.07	.25	.08	.05	.24	.10	.41	.05	.32
Total, Labor	1.06	1.90	.69	.44	2.09	.76	2.21	.41	1.29
Stationary Equipment									
Repair and Maintenance	.001	.01	0	0	.21	0	.06	.01	0
Parts and Supplies	.001	.02	0	0	0	0	0	0	0
Other Equipment Expense	.04	.001	.004	0	.10	0	.01	0	0
Total Stationary Equipment	.04	.03	.004	0	.31	0	.07	.01	0
Vehicular Equipment									
Repair and Maintenance	.08	.22	.12	.16	1.25	.29	.46	0	.08
Parts and Supplies	.32	.31	(1)	.23	(1)	(1)	.76	0	.06
Rental	.01	.04	.71	.05	1.13	.07	.01	.45(2)	0
Fuel and Oil	.04	.18	(5)	.07	.25	.13	.21	.12	.14
Total, Vehicular Equipment	.45	.74	.83	.51	2.63	.48	1.43	.57	.28
Facilities and Site Maintenance	.01	.20	.002	.03	.32	1.52	.04	.04	.15
Utilities	.01	.01	.004	.001	.02	.02	.01	.002	0
Cover Material	0	.81	0	0	0	0	.07	0	0
Administrative Expense	.19	.09	.001	.01	.05	.09	.11	.03	0
Other Expenses	.01	.04	.01	.05	0	.02	.02	.24	0
Total, Operating Cost/Ton	1.77	3.82	1.54	1.04	5.41	2.89	3.96	1.31	1.72

(1) Included in Repair and Maintenance
(2) Includes Repair and Maintenance, and Parts and Supplies
(3) Included in Repair and Maintenance and Rental
(4) Includes a portion of Repair and Maintenance, and Parts and Supplies
(5) Included in Rental
(6) Computed from only those sites reporting a cost

TABLE 32 (a)

Cost Item	Site No. 10	11	12	13	14	15	16	17	Average
Labor									
Salaries and Wages	1.60	1.88	.79	.43	.45	.39	1.28	.76	.99
Fringe Benefits	.53	.48	.15	.08	.11	.06	.31	.23	.21
Total, Labor	2.13	2.36	.94	.51	.57	.45	1.59	.99	1.20
Stationary Equipment									
Repair and Maintenance	0	0	.03	0	0	.02	0	.002	
Parts and Supplies	0	0	.06	0	.01	(2)	0	0	
Other Equipment Expense	0	0	.01	.001	0	0	0	0	
Total Stationary Equipment	0	0	.10	.001	.01	.02	0	.002	.04
Vehicular Equipment									
Repair and Maintenance	.20	1.23	.19	.30	.07	.21	.65	.26	
Parts and Supplies	.13	(1)	.37	(1)	.11	(1)	.15	(3)	
Rental	0	0	0	.36	.01	0	.05	.85(4)	
Fuel and Oil	.34	(1)	.15	.02	.12	.21	.12	.18	
Total, Vehicular Equipment	.67	1.23	.71	.68	.31	.42	.97	1.30	.84
Facilities and Site Maintenance	.05	0	.18	0	.08	.005	.02	0	.16
Utilities	.001	.01	.01	.003	.002	.01	.01	.02	.01
Cover Material	0	0	0	0	0	0	0	0	.44(6)
Administrative Expense	0	.12	.05	.02	.03	.02	.01	.09	.05
Other Expenses	0	.16	.17	.001	.002	.06	0	0	.05
Total, Operating Cost/Ton	2.86	3.88	2.16	1.22	1.00	.98	2.60	2.40	2.39

Utilities. Utilities costs averaged $.01 per ton, ranging from zero to $.02 per ton. Utilities costs typically included electricity, gas, waste, sewer, and telephone charges directly associated with the operation of the landfill.

Cover Material. The two sites which purchased cover materials reported costs of $.07 and $.81 per ton. Fifteen of the surveyed sites obtained cover material from the landfill itself. A six-inch cover requirement was common for landfills receiving non-shredded wastes.

Administrative Expense. Administrative expenses averaged $.05 per ton, ranging from zero to $.19 per ton. Costs associated with administering a sanitary landfill can include a variety of expenses and differed significantly with each operation. Typically, administrative expenses can include costs for printing, data processing, billing, accounting services, paper and forms, uniforms, postage, and cleaning supplies.

Other Expenses. Other expenses ranged from zero to $.24 per ton, and averaged $.05 per ton. Examples of costs included in this category are consulting engineering services, insurance, security services, and taxes.

Variations in Cost Elements

The operating and capital costs per ton vary substantially among the 17 survey sites. Five major variables influencing landfill costs are: (1) tons received per day; (2) depreciation schedules; (3) wage and fringe benefits rates; (4) characteristics of the land and (5) shredded wastes.

Tons Placed Per Day. As shown on Table 32, operating costs per ton varied from $.98 cents to $5.41 per ton. Most of this variation is attributed to economy of scale. In general, large landfills had lower costs than small landfills. The average operating cost per ton for sites under 400 tons per day was $2.56, while the average for those sites over 500 tons was $2.07 per ton.

Noticeable cost differences exist among the sites within these two ranges, however. Some differences can be explained by examining the influence of other factors on the cost per ton. In the under 500 tons per day range, for example, Site No. 5 had a very high operating cost per ton; this was due primarily to high vehicular maintenance costs. Also, Site No. 4, which reported a very low operating cost per ton, received only shredded waste. This reduced the maintenance costs for the landfill equipment.

Site No. 2, which receives over 1,000 tons per day, showed higher costs than for the other sites in that range. This was attributable to the relatively high wage rates and to the fact that cover material was purchased.

Depreciation Schedules. A shorter depreciation period results in a higher annualized capital cost. Site Nos. 1, 10, and 12 have comparatively high costs per ton. These sites use shorter depreciation periods than the mode, as given in Table 33, whereas, Site Nos. 13, 17, and 3, reporting low capital costs per ton, use depreciation periods longer than most of the sites. Table 33 shows the depreciation periods used by all of the surveyed landfills for site construction, stationary equipment, and vehicular equipment categories.

Wage and Fringe Benefits Rates. Average hourly wages paid to landfill supervisors and employees are displayed in Table 34. The variations in these rates can be used to explain some of the differences in operating costs. For example, Site No. 1, which had the lowest employee hourly wage rate of $3.19, had an operating cost per ton of $1.77. This was 31 percent lower than the average wage rate of $2.63 for all sites receiving under 500 tons per day. Site Nos. 6 and 10, paying wages of $5.88 and $6.86, respectively, had operating costs over 10 percent higher than other sites in the same daily tonnage range. Table 34 also shows the fringe benefits rate reported by each of the sites. The average rate was 19 percent, with a range between 7 percent and 33 percent.

There was a wide variation in tons placed per employee and supervisor which contribute significantly to high labor cost per ton. As shown on Table 35, tons per production employee ranged from 25 to 173 tons on an 8 hour basis. Often the low worker productivity was the result of inadequate equipment. The use of 2 or 3 small dozers instead of 1 large compacter contributed to low tons per employee on sites 2, 5, 6, 8 and 16. The use of several dump trucks to move cover material on sites 1, 6, 7, 11, 12 and 16 instead of 1 or 2 large scrapers increased the labor force and resulted in higher labor costs than necessary. In one instance at site 2, the use of 3 supervisors instead of the customary one contributed to low productivity.

Characteristics of the Land. A significant factor affecting landfill operating and capital costs is the physical condition of the land, i.e., the availability of cover material, the relative difficulty of excavation, and the necessity of grading or landscaping and of controlling ground water pollution and methane production. This factor can have a significant influence on costs, including capital costs for equipment and operating costs for equipment usage, labor, and cover material.

Two of the surveyed sites reported costs for the purchase and transportation of cover material. Site No. 2, which purchased some cover material from an outside source, and hauled other cover material from distant areas of the landfill, reported a cover material cost per ton of $.81. Site No. 7 reported $.07 per ton for the handling of cover material.

Landfills with excavation and grading problems can have higher capital costs and operating costs per ton than other landfills within the same tons per day range. The types of equipment used at each site is

TABLE 33

DEPRECIATION PERIODS FOR 17 LANDFILL SITES (YEARS)

Site No.	Site Construction	Stationary Equipment	Vehicular Equipment
1	20	--	3-6
2	16	10	5-10
3	20	8	8
4	--	--	5
5	5-10	10	5
6	--	10	5
7	7	10	8
8	16	10	5
9	--	--	6
10	5	5	6-10
11	15	10	5-8
12	20	3	3
13	--	--	5-27
14	10	--	5
15	10	10	5
16	15	--	5-8
17	13	13	7
Mode	10-15	10	5
Range	5-20	3-13	3-27

TABLE 34

WAGE RATES AND FRINGE BENEFITS RATES FOR 17 LANDFILL SITES IN 1975

Site No.	Supervisor Avg. Hourly Wage	Employee Avg. Hourly Wage	Fringe Benefits Rate
1	$4.18	$3.19	7%
2	7.32	4.56	15
3	9.58	8.34	14
4	3.90	3.90	12
5	5.44	4.44	13
6	8.96	5.88	14
7	6.50	5.10	23
8	--	5.70	14
9	8.19	7.72	33
10	8.19	6.86	33
11	4.15	4.15	26
12	5.14	3.94	19
13	5.00	3.62	18
14	5.31	4.13	25
15	4.00	3.87	14
16	--	--	24
17	5.75	4.48	30
Average	5.96	4.99	19
Range	3.90 - 9.58	3.19 - 8.34	7 - 33

TABLE 35

AVERAGE DAILY TONS FOR LANDFILL PERSONNEL

Site No.	Tons/Day	No. Of Supervisors	Tons/ Supervisor	No. Of Employees	Tons/ Employee
1	107	1	107	2	54
2	1,014	3	338	21	48
3	548	.5	1,096	5	110
4	264	1	264	2	132
5	99	1	99	4	25
6	205	1	205	5	41
7	172	1	172	4	43
8	753	1	753	5	151
9	173	.5	346	1	173
10	275	1	275	8	34
11	233	1	233	9	26
12	577	1	577	21	28
13	162	.3	486	2	81
14	555	1	555	7	79
15	360	1	360	3	120
16	530	1	530	13	41
17	255	1	255	4	64
Average	370		391		73
Range	99 - 1,014		99-1,096		25-173

TABLE 36

EQUIPMENT FOR 17 LANDFILL SITES IN 1975

Site No.	Scales	Dozers	Loaders	Compactors	Scrapers	Misc. Equip.	Misc. Vehicles
1			1	1	1		1 pick-up 4 dump trucks
2	2	3	2	3	4	1 dragline 1 grader 1 water truck 3 air compressors	3 pick-ups 1 packer truck 1 lawn tractor 1 industrial tractor
3	1	3		1	2	1 water truck	
4			1	1	1	1 water truck	
5	1	3	1	1			1 pick-up
6	1	2	1	1	1	1 water truck	2 pick-ups 1 dump truck
7	1		2	1	1		1 pick-up 1 dump truck
8	1	2	1	1	1	1 water truck	
9			1				
10	1	1	4	1	2		
11	1		1	1			2 dump trucks
12	2	7		2	1	2 draglines 1 water truck	1 tire cutter 1 pick-up 4 open body trucks 1 lowboy tractor trailer
13		1			1		1 1/2 ton truck
14	1		2	1	1	1	1 3/4 ton truck
15	1	2					
16		6	1	1		2 draglines 1 grader 1 water tractor	3 pick-ups 1 trash pump 1 lowboy tractor trailer 1 sweeper 5 dump trucks
17	1	3	2	1	1		1 pick-up

presented in Table 36. It reveals that Sites Nos. 2, 10, 12, and 16 utilized scrapers, draglines, and graders. This equipment is typically found at landfills where excavation and grading problems exist. Each of these sites show higher capital costs and operating costs than other sites within the same daily tonnage range.

Shredded Solid Waste. At three of the survey sites, over 60 percent of the solid wastes received were shredded. The use of shredded solid wastes at a landfill typically has the following cost-effective advantages:

- The life of the landfill can be extended since shredding reduces the volume of solid waste.
- Daily cover of shredded solid waste may not be required.
- Shredded waste is easier to compact at a landfill, saving labor and equipment expense.
- Shredded waste does not attract vermin, blow as freely, or cause fires, thereby reducing site maintenance costs.

The operating and capital costs per ton for the three sites receiving shredded solid wastes is presented in Table 37. The difference between the cost per ton of each site and the average of the remaining 14 sites is shown as a positive or negative percentage. The three sites averaged a total cost per ton 45 percent lower than landfills receiving non-shredded solid wastes.

A comparison of the cost reported by Sites Nos. 9 and 10 reveals a distinct cost difference between landfilling shredded and non-shredded wastes. Site Nos. 9 and 10 are, in fact, two separate landfills that are operated by the same municipality. Site No. 9, which receives shredded waste, had a total cost per ton of $2.62 compared with $4.41 for Site No. 10, which receives non-shredded wastes.

Cost Estimating

This section presents procedures for estimating the capital and operating costs of a sanitary landfill. When available, current local cost data should be utilized with these procedures.

Capital Costs. Costs for the following categories should be developed in estimating capital costs.

(1) Land. The capital cost for land can vary greatly, depending upon the location, condition, and amount of the land. Land costs for the surveyed sites are shown

TABLE 37

OPERATING AND CAPITAL COSTS PER TON FOR 3 LANDFILL SITES RECEIVING SHREDDED WASTES IN 1975

Site No.	Tons/ Day	% of Wastes Shredded	Operating Cost/ Ton	Difference- Average Cost/Ton	Capital Cost/Ton	Difference- Average Cost/Ton	Total Cost/ Ton	Difference- Average Cost/Ton
4	264	64%	$1.04	-60%	$.46	-36%	$1.50	-55%
9	173	100	1.72	-34	.90	+25	2.62	-21
13	162	100	1.22	-53	.19	-74	1.41	-58
Average			$1.33	-49%	$.52	-28%	$1.84	-45%

TABLE 38

LAND COSTS FOR 17 LANDFILL SITES IN 1975

Site No.	No. of Acres	Land Cost	Cost/ Acre	Site Construction Cost	Cost/Acre
1	60	$ 6,012(1)	-	$162,331	$ 2,705
2	81	85,131	$ 1,051	200,187	2,471
3	200	190,000	950	33,000	165
4	60	60,000	1,000	0	-
5	44.7	93,722	2,097	5,675	126
6	180	165,000	917	0	-
7	33	40,000	1,212	40,500	1,227
8	215	107,625	500	2,000	9
9	14	56,000	4,000	170,900	12,207
10	24	50,000	2,083	344,100	14,337
11	295	295,000	1,000	58,649	199
12	83	83,000	1,000	5,000	60
13	1,500	244,600	163	0	-
14	137	283,000	2,067	156,800	1,144
15	123	6,000(1)	-	111,060	903
16	68	680,000	10,000	9,516	140
17	160	65,000	406	90,100	563
Average			$ 1,896		$ 2,590
Range			$ 163 - 10,000		$ 9 - 14,337

(1) Land is leased on an annual basis.

in Table 38 It is recommended that local land value be used in estimating the cost category.

Land can be treated as a depreciable or non-depreciable asset in developing the capital costs of a sanitary landfill. If the land is considered to be a depreciable asset, the annualized capital cost is determined by dividing the land cost less its salvage value by the expected life of the landfill in years. If the land is considered to be a non-depreciable asset (the land cost equals its salvage value), the annualized capital cost would be zero.

Estimated land cost . . . . . .(total) _____
(annualized) _____

(2) Site construction. Site construction costs vary with each landfill, depending upon the condition of the land, the availability of existing roads, and other factors.

It is recommended that local site construction estimates be utilized. If not available, an average cost of $370 per ton of daily capacity may be utilized.

Annualized site construction capital costs can be determined by dividing the estimated total site construction costs less any salvage value by the depreciation period in years. Periods from 10 years to 15 years are common for items in the landfill site construction cost category.

Estimated site construction cost . . . . . (total) _____
(annualized) _____

(3) Stationary equipment. Stationary equipment utilized at a landfill can include scales and other equipment. Generally, stationary equipment investment is a very small percentage of total capital costs. Most surveyed sites reported costs between $6,000 and 12,000.

In calculating annualized capital costs for stationary equipment, a depreciation period of 10 years can be used.

Estimated stationary equipment cost . . . . . .(total) _____
(annualized) _____

(4) Vehicular equipment. The purchase of vehicular equipment tends to be the largest capital expense at a landfill. Typically, only one compactor is required for landfills receiving under 500 tons per day. Compactors may not be required at landfills receiving only shredded wastes. Also, only one scraper is required at landfills operating under 800 tons per day.

Local costs should be utilized in estimating vehicular equipment costs. The total vehicular equipment capital costs for most of the surveyed sites receiving under 500 tons per day was from $37,000 to $200,000. Sites receiving more than 500 tons per day had a vehicular capital cost between $225,000 and $575,000.

Annualized vehicular equipment costs may be calculated using a five year depreciation period.

Estimated vehicular equipment cost . . . . . .(total) _____
(annualized) _____

Operating Costs. Annual operating costs may be estimated by developing costs for the following categories.

(1) Labor. This category consists of the costs of salaries and wages and fringe benefits. The annual salaries and wage costs can be estimated as follows:

Number of personnel by job category	x	Hourly wage for job category	x	Hours worked per day	x	Days of operation per year

Generally, only one supervisor is required at a landfill. The number of employees can be estimated using an average of one employee per 73 tons of daily operation.

Local hourly wage rates should be used when available. If they are not available, the following average rates may be used: supervisor, $5.96 per hour; and employee, $4.99 per hour.

The fringe benefits cost if determined by multiplying the salaries and wages cost by the local fringe benefits rate. If this is not available, an average rate of 19
The fringe benefits cost is determined by multiplying the salaries and wages cost by the local fringe benefits rate. If this is not

Estimated fringe benefits cost. . . . . _____
Total, estimated labor cost. . . . . _____

(2) Stationary equipment. An average of $.05 per ton can be used for estimating stationary equipment operating costs.

Estimated stationary equipment cost . . . . . _____

(3) Vehicular equipment. An average cost of $.83 per ton can be used to estimate vehicular equipment operating costs for landfills purchasing most of their equipment. If a more detailed estimate

is desired, one can be developed as described below, in terms of costs for repair and maintenance, parts and supplies, and fuel and oil.

Costs for vehicular equipment repair, maintenance, parts and supplies can be calculated using the following average costs per ton based on the surveyed sites:

- Landfills receiving shredded wastes--$.28 per ton
- Landfills receiving non-shredded wastes of under 500 tons per day--$.65 per ton
- Landfills receiving non-shredded wastes of over 500 tons per day--$.33 per ton

Fuel and oil costs can be determined using an average $.15 per ton.

Estimated vehicular equipment cost . . . . . _____

(4) Facilities and site maintenance. An average cost per ton of $.19 can be used to estimate costs of facilities and site maintenance.

Estimated facilities and site maintenance cost . . . . . _____

(5) Utilities. Costs for utilities can be provided for by using an average $.01 per ton.

Estimated utilities cost . . . . . _____

(6) Cover material. The need to purchase or transport cover material depends on each situation. An estimate for this category should be made based on the site requirements and local costs of cover material.

Estimated cover material costs . . . . . _____

(7) Administrative expense. Administrative expenses may be estimated utilizing an average of $.06 per ton.

Estimated administrative expense . . . . . _____

(8) Other expenses. A provision for other expenses may be made based on the average of $.06 per ton.

Estimated other expenses . . . . . _____

Tables 39 and 40 may be used in developing capital and operating cost estimates for landfill sites.

TABLE 39

LANDFILL CAPITAL COST WORKSHEET

1	2	3	4	5	6	7	8
Cost Category	Typical Items Included	Capital Cost	Depreciation Period	Annualized Cost	Cost/Ton	Survey Average Cost/Ton ($)	Survey Cost Ton Range ($)
Land	Survey, legal, land cost					.13	.02 - 42
Site Construction	Planning and designing, site preparation, demolition, fencing, road construction, facilities construction					.13	0 - .85
Stationary Equipment	Scales, major shop equipment, communication equipment, badge readers, air compressors					.01	0 - .04
Vehicular Equipment	Dozers, loaders, scrapers, graders, compactors, draglines, tractors, water vehicles					.39	0 - 1.16
Other Equipment	Office equipment, maintenance equipment					--	--
Totals						.68	.07 - 1.55

TABLE 40

LANDFILL OPERATING COST WORKSHEET

1	2	3	4	5	6
Cost Category	Typical Items Included	Annual Cost	Cost/Ton	Survey Cost/Ton Average (1)	Survey Cost/Ton Range (1)
Labor - Salaries and Wages	Regular, temporary, and overtime compensation to employees, e.g., supervisors, scalement, equipment operators			.89	.38-1.38
Labor - Fringe Benefits	Workmen's Compensation, FICA, employee hospital, life, and dental insurance, retirement			.21	.05-.53
Stationary Equipment	Repair and maintenance (in-house and contracted), parts and supplies, shop and communication equipment purchases (non-capitalized)			.04	0-.31
Vehicular Equipment	Repair and maintenance (in-house and contracted), parts and supplies, rental, fuel, and oil			.84	.21-2.63
Facilities and Site Maintenance	Maintenance services (in-house or contracted), janitorial services, building and road materials, fencing, plumbing supplies, vector control, landscaping			.16	0-1.52
Utilities	Water, gas, electricity, sewer, telephone			.01	0-.02
Cover Material	Purchase of cover material, transfer of cover material			.44(1)	.07-.81(1)
Administrative Expense	Office supplies, uniforms and cleaning, training, printing, postage, billing and accounting services, legal services, data processing			.05	0-.19
Other Expenses	Consulting and engineering services, liability insurance, taxes, security services, lease or rental of land			.05	0-.24
Totals				2.39	.98-5.41

(1) Computed for only those sites reporting cover material costs.